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POTATOES

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POTATOES

The average annual farm value of potatoes produced in Maine was almost thirty seven million dollars for the five years 1940 to 1944 inclusive.[1] Potato production continues to be Maine's most important agricultural enterprise. The research program with the problems of the potato industry, therefore, receives considerable attention. This report is very largely for the 1945 crop season. Conclusions are seldom warranted on the basis of one year's results. As sufficient data are accumulated on a particular study, all of the results are brought together in a single publication.

DISEASES AND INSECTS[2]

Studies continue on the important disease and insect problems in potato production. Bacterial ring rot, late blight, and leafroll continue to cause the most concern among the potato diseases. Aphids and flea beetles are no doubt the worst insect offenders.

Bacterial Ring Rot. Reiner Bonde, M. R. Harris, Donald Merriam. New seedling varieties have been found which are resistant to bacterial ring rot. Some of these are ready for a thorough test on table stock quality, yielding ability, and other desirable characters. Until such new varieties are available commercially it will be necessary to adopt sanitation methods for the control of this disease.

Non-Copper Disinfectants for the Control of the Ring-Rot Organism. Reiner Bonde. Disinfectants are needed that will destroy the ring-rot bacteria and not injure the seed potatoes. These or other disinfectants are needed that will kill the bacteria and not corrode or injure the metal parts of the potato machinery or equipment that is treated. Materials used for disinfecting potato storage bins should not leave objectionable odors.

A miscellaneous group of materials considered to possess bactericidal properties were tested in 1945 for the purpose of determining their ability to kill the ring-rot bacteria on freshly cut potato

[1] Cash Receipts from Farming. The United States Department of Agriculture, Bureau of Agricultural Economics. January, 1946.

[2] A substantial sum from the cent-a-barrel potato tax has been available for the studies on "Potato Diseases and Insects," on "Soil Fertility in Central Maine," and on "Potato Products."

seed pieces. (See Table 1.) None of these materials reduced appreciably the amount of ring rot that developed. The corrosive sublimate solutions (acidified and nonacidified) used on the treated controls were the only materials that were effective in killing the bacteria and in reducing the amount of ring rot. Corrosive sublimate, however, injured the seed pieces and reduced the stand significantly. The other materials under test did not injure the seed pieces sufficiently to cause a reduction in the stand. All treatments were effective in destroying the soft rotting bacteria and helped to preserve the seed pieces. Some of these chemicals can be used profitably in the treatment of seed potatoes for the control of seed piece decay caused by certain fungus and bacterial organisms.

Copper-Containing Fungicides as Disinfectants for Control of Ring Rot. Reiner Bonde. Previous experiments have shown that treating the tubers in solutions containing certain of the neutral copper fungicides was effective in reducing the amount of tuber rot caused by the late blight fungus. These fungicides were tried in 1945 for their value as disinfectants for the control of ring rot.

Contaminated seed pieces, in all cases but one, were given five-minute treatments in the different copper containing solutions. The seed pieces were planted in the field immediately after treatment.

None of the neutral copper fungicides, when used for five-minute treatment periods, reduced materially the amount of ring rot that developed. (See Table 2.) Yellow copper oxide appeared to be a somewhat better bactericide than the other neutral coppers. The copper sulphate solution reduced the amount of ring rot that developed to five and four per cent for the two concentrations at which it was used. Copper sulphate, however, was very toxic to the seed pieces and reduced the stands significantly. The neutral coppers, on the other hand, were less toxic and did not injure the seed pieces sufficiently to reduce the percentage of emergence.

The percentage of ring rot that developed was markedly less when the period of treatment in the Tribasic Copper Sulphate solution was increased to 12 hours. It is possible that some of the copper fungicides can be used effectively as disinfectants for the control of ring rot by increasing the length of the treatment.

Resistance to Ring Rot in Varieties and Certain Selected Seedlings. Reiner Bonde. Five named varieties and six selected seedlings were compared in 1945 in one experiment. This was done to determine whether certain selections intended for use in making

crosses actually are resistant to the disease or merely have escaped becoming infected in the studies previously conducted.

All of the numbered seedlings included in this test and the variety President continued to be highly resistant to infection and contracted a relatively small amount of ring rot as a result of the inoculations.

It should be noted that selections S 824, S 850, S 870, and S 47102 showed very little, or no, ring rot in spite of the fact that the same seed stocks had been inoculated and used for similar experiments for three successive seasons. In contrast the Green Mountain, Katahdin, and Spaulding Rose varieties were eliminated after one season because the seed stocks were all infected and the tubers decayed in storage.

Ring Rot Resistance in Progenies from Crosses with Resistant Varieties. Reiner Bonde. In 1945 different progenies were tested again for resistance to ring rot in the field. A high percentage of the seedlings in the progenies possessed resistance to ring rot when resistant parents were used for making the crosses. The percentage of resistant seedlings in the different progenies varied from 0 to 92.3, depending on the parents that were used. A high percentage of resistant seedlings resulted when President, 336-18, 336-144, 0.55, 46952 or 47102 were used as parents. The number of resistant seedlings found in the progenies increased when both parents were resistant or when a resistant parent was self pollinated.

Seedlings 96-28, 96-44, 96-345, 336-18, 336-144 and variety President possess resistance, also, to late blight infection. It is significant that many of the seedlings were highly resistant to ring rot, and, also, were resistant to late blight. Furthermore, a relatively large number of the seedlings included in the 1945 ring rot resistance test plot were rather early maturing and possessed desirable marketing qualities. This is a contrast to the results of previous years when most of the resistant new seedlings were late maturing, produced ill-shaped tubers and were unsuited for the market.

Comparative Yields of Ring-Rot Resistant Seedlings and Standard Varieties. Reiner Bonde. Four seedlings resistant to ring rot were compared in 1945 for yielding ability with Pawnee, a newly introduced variety, and with Green Mountain, Katahdin, Sebago, and Irish Cobbler. Seedling 47102 gave the highest yields for the eight varieties that were included in the test. (See Table 3.) It also was superior regarding the general appearance of the crop,

the tubers being uniform in size with an attractive white color.

Seedling 47102 has been highly resistant to ring rot in trials conducted at Aroostook Farm for a period of six years. It has contracted only a trace of the disease, even after freshly cut seed pieces were heavily contaminated with viable ring rot bacteria and planted immediately in the field.[3] The progeny from hills inoculated with ring rot in 1941 and 1942 have shown no apparent symptoms of the disease to this date. All of the tubers and plant progenies from the similarly inoculated seed stocks of the Katahdin and Green Mountain developed symptoms of the disease.

Green Mountain, long considered a good yielding variety in Maine, yielded at the rate of 163 barrels (451 bushels) per acre compared with 178 barrels (492 bushels) for seedling 47102. Furthermore, 20 per cent of the Green Mountain tubers developed net necrosis, a condition that was not noted in the new seedling variety. Seedlings 0.55 and 46952, also resistant to ring rot, gave rather small yields in these tests. Seedling 336-144 yielded rather well but is too late in maturity for Maine conditions.

It may be noted that the Katahdin variety yielded only 116 barrels (377 bushels) per acre in these trials. This variety often has produced rather low yields in Maine. This is important to consider in view of the fact that Katahdins are rapidly replacing the other varieties. It is possible that the reduction in the average yield rate in Maine during the past few years is due in part to the partial replacement of the Green Mountain variety with Katahdin.

Ring Rot Survey. M. R. Harris. During the season of 1945 a survey was made of seed plots belonging to growers financed by the Federal Farm Security Administration. These growers were located in several sections of Aroostook County and were served by Farm Security Administration offices in Fort Kent, Caribou, Presque Isle, Van Buren, and Houlton. A total of 48 farms was surveyed, on which there were 1,067 acres of commercial potatoes. Acreages by varieties in several sections of the County are shown in Table 4. Seed plots of these farmers totalled nearly 100 acres. In size they ranged from less than one acre up to six. Each grower purchased seed of a superior quality, much of it certified and all

[3] Experiments conducted by the Wyoming Agricultural Experiment Station also have shown that seedling 47102 is highly resistant to ring rot besides being a desirable marketing variety. They have proposed to introduce this variety under the name Teton.

was believed to have been free of bacterial ring rot. The actual amounts of ring rot found in the seed plots and commercial plantings are given in Table 5.

Proper methods in planting, growing, digging, and storing the seed plot crop were explained to the growers by Farm Security Administration officials. The growers followed this advice rather well. (See Table 6.) Approximately two thirds of the growers planted and dug their seed plots before the commercial crop. Three fourths or more of the growers did some disinfecting of tools, barrels, and bins. A number of instances were noted where a grower apparently had been able to eradicate ring rot from his farm by the seed plot method.

The survey data show that of the 48 farmers having seed plots, 45 of them had been successful in keeping ring rot out of their seed for 1946. (See Table 7.) By way of contrast, 17 out of the 48 farmers were found to have ring rot in their commercial potatoes while 31 farms were entirely free of the disease.

It is interesting to note that of the farms surveyed in 1944 and 1945, where a seed plot was grown, 79 per cent of the commercial growers had ring rot in 1944. In a comparable area in 1945 this had dropped to 35 per cent. It is assumed that this improvement was due largely to an educational program which emphasized the proper methods to be employed in freeing a farm of ring rot.

Ring Rot Elimination from Infected Seed Lots. M. R. Harris. During September 1944, three seed lots of five barrels each were examined for the presence of ring rot. All the lots had a past history of ring rot infection. Two of the lots were of the Spaulding Rose variety and one was of the Katahdin variety. Ring rot was found in one of the Spaulding Rose lots and in the Katahdin lot, while one lot of Spaulding Rose was apparently free. From each lot, 200 tubers were carefully selected and found to show no surface symptoms of ring rot. After storage for several months, each tuber was cut at the stem end and examined under the ultra-violet light for symptoms of ring rot, but none were observed. All of the tubers were planted and observed during the 1945 season. No symptoms of ring rot appeared during the growing season and no tubers showing ring rot were found when the crop was dug.

Ring Rot in Potato Seeds. M. R. Harris. A study to determine if bacteria find their way into potato seeds was begun during the 1945 season. In the plot on Aroostook Farm used to test

seedling varieties for resistance to ring rot, 132 seed balls were collected from seedling plants, and 68 from Katahdin plants. No seed ball of the 200 tested failed to produce viable seed and with few exceptions more than half of the seeds planted for each seed ball were able to produce a seedling plant.

In appearance the seedlings varied from quite stunted and weak to very large and vigorous. A total of 62 plants were selected as most likely to show ring rot on a basis of appearances. Weak, malformed plants, many lacking a deep green color, were surface sterilized and plated. A number of the plants showed cultures of bacteria after several days of incubation. Each culture was tested with the gram stain and twelve of the cultures closely resembled ring rot bacteria.

LEAFROLL INCLUDING NET NECROSIS. ***Resistant Varieties.*** HIGHMOOR FARM TESTS. Donald Folsom. Leafroll spread the worst in 1944 of any year since the test was begun at Highmoor Farm in 1938. Healthy Green Mountains contracted 91 per cent leafroll and Chippewas 93 per cent, in 1944 as shown by readings in 1945. However, several of the seedling varieties introduced in 1939 contracted no leafroll in 1944, and others contracted less than 10 per cent. These may be called Highmoor Farm leafroll-resistant seedlings. They were used as parents in new crosses introduced in 1943, a year in which the new crosses contracted much less leafroll than was usual for new crosses. This was no accident, because in 1944, a year of heavy leafroll spread, the same crosses still showed more resistance than most have shown. Furthermore, in each year the crosses made with both parents consisting of Highmoor Farm leafroll-resistant seedlings, contracted less leafroll than the crosses made with only one parent a resistant seedling.

Leafroll-resistant seedlings were used as parents in some crosses introduced in 1944. Twelve times as many seedlings in such crosses remained free from leafroll in 1945 as in crosses made with other parents which included certain foreign commercial varieties supposed to be leafroll-resistant. It appears best hereafter to test only such crosses as have one or both parents leafroll-resistant in the Highmoor Farm test. Here it is possible to have one parent a commercial variety or a commercially acceptable leafroll-resistant seedling. A number of the seedlings introduced in 1943 have shown both leafroll resistance and commercially desirable characteristics.

Comparison of Highmoor Farm Leafroll-Resistant Seedlings on Aroostook Farm. Donald Folsom, F. H. Steinmetz. Seventeen seedlings that had shown field resistance to leafroll at Highmoor Farm were compared in 1945 on Aroostook Farm with 17 Chippewa and 17 Green Mountain plots. Several yielded as much as Chippewas, and none as much as Green Mountains. The more stems per hill in 1945, the more tubers there were per hill and the lower was the average weight per tuber. Only a few ranked along with Chippewas and Green Mountains in average tuber weight. Thirteen of the seedlings had been studied similarly in 1944 on Aroostook Farm. Their records for the two years showed a significant correlation between 1944 behavior and that of 1945 with respect to ratio of yield to Green Mountain yield, number of stems per hill, number of tubers per hill, and the average tuber weight. Most were discarded because of undesirable commercial characteristics in one or both of the two years. Only one seems to have promise in commerce, being very similar to Chippewa but practically field-immune to leafroll.

Natural Field Spread of Leafroll in Different Varieties in 1944. Reiner Bonde, Geddes W. Simpson. The spread of leafroll in Aroostook County was very severe in 1944 as shown by the amount of the disease that was present in many seed stocks planted in 1945.

General observations have indicated that the different commercial varieties being grown in Aroostook County differ greatly in susceptibility to leafroll infection under field conditions. Data were secured on Aroostook Farm which give some information regarding the relative susceptibility to leafroll infection of a number of varieties.

The different varieties were grown in 1944 from relatively healthy seed stocks in a field where they received the same cultural treatments during the summer. Samples of the different varieties were taken just prior to the time of harvest. These samples were planted in 1945 and records taken of the amount of leafroll in the plants that emerged.

The results of these observations are as follows:

Variety	Per cent leafroll in progeny grown in 1945
Irish Cobbler	57
Chippewa	92

Green Mountain	89
President (No Blight)	99
Harmony Beauty	47
Katahdin	29

Leafroll Infection in Different Varieties Resulting from Inoculations with Viruliferous Aphids. Reiner Bonde, Geddes W. Simpson. Seven named varieties and two unnamed seedlings were used in these preliminary experiments. Peach aphids (*Myzus persicae*) were reared on potato plants infected with leafroll. Pieces of the leafroll plants having approximately five viruliferous aphids were placed on each of the healthy plants of the different varieties included in the test. The plants were inoculated July 27 when 6 to 10 inches high. Observations for the presence of leafroll were made August 13.

The varieties Green Mountain, Katahdin, Sebago, and seedling 0.55 were very susceptible to leafroll under the conditions of this experiment. (See Table 8.) General field observations have indicated that Green Mountain and Sebago are very susceptible to leafroll infection under field conditions, and it was expected they would readily become infected by artificial inoculation methods. However, Katahdin has appeared to be quite resistant to leafroll infection under field conditions. It is possible that the inoculation methods in this test are too drastic and will eliminate as being susceptible some varieties that are quite resistant under field conditions.

Teton, Pawnee, Houma, and Seedling 46952 appear to possess resistance to leafroll infection. The results with 46952 are of special interest because progenies resulting when this variety is used as a parent also appear to have a high percentage of seedlings that are resistant.

Reaction of Progenies of Different Crosses to Artificial Inoculation with Leafroll Using Viruliferous Aphids. Reiner Bonde, Geddes W. Simpson. Single tuber progenies of a number of crosses were received in 1944 for this work. The tubers of the progenies were planted in the field and the plants that resulted were infested with viruliferous aphids that had been reared on leafroll plants in the greenhouse.[4]

[4] Leafroll plants that were heavily infested with viruliferous aphids were taken to the field and used for inoculating the plants of the different progenies. Small pieces of the leafroll plants each with approximately five viruliferous

Records were made on the number of seedlings in each progeny that gave symptoms of leafroll the current season and in the plants that developed the disease when the tubers from the inoculated plants were grown the following summer. The progeny obtained from crossing President with Katahdin possess very few seedlings that are resistant to leafroll. Only one seedling of this cross survived the inoculation and it was discarded because of undesirable tuber and plant characteristics.

When the variety Triumf was used as one parent in the crosses, from 6.2 per cent to 9.1 per cent of the seedlings in the progenies failed to get leafroll as a result of the inoculations. (See Table 9.) Approximately 46 per cent of the seedlings failed to get leafroll in the progenies obtained by selfing this variety.

It appears that Triumf possesses factors for resistance to leafroll which are transmitted to the progeny when this variety is used as a parent. However, the seedlings produced by this variety are very undesirable from the marketing standpoint. Thirty-nine selections were made from the progeny of Triumf selfed. These appear to have better tuber shape and plant characteristics than the parent variety. One of these selections may prove to be a better parent than Triumf for further breeding work where resistance to leafroll is desired.

Some resistant seedlings may be expected if selection 1241-91 is used for crossing with several selections of U.S.D.A. pedigree No. 792.

Time of Inoculation as Related to Leafroll and Subsequent Development of Net Necrosis. Geddes W. Simpson, Reiner Bonde. It has been observed that differences in the amount of net necrosis occur in Green Mountains even though leafroll readings were similar. In an attempt to determine some of the reasons for these results, an experiment was set up whereby healthy Green Mountain potato plants were grafted (by the inarch method) with leafroll plants at regular intervals throughout the season. Tubers from the grafted Green Mountain plants were saved and grown the following season to determine the leafroll present. Tubers were examined

aphids were placed at the apex of the young plants being tested for resistance to the disease.

The seedlings were infested with viruliferous aphids in 1944 and observations on leafroll were made the current season and in 1945 on the plants produced from the tubers that were harvested from the inoculated plants.

for net necrosis after a period in storage at 50° which has been found satisfactory to produce the maximum amount of net necrosis.

The results of grafting in the summer of 1944 indicate reasonably successful transmission of leafroll by the method employed and show that the percentage of net necrosis varied considerably. (See Table 10.) The data indicate a rise in the percentage of tubers showing net necrosis as the season for inoculation was advanced until a peak was reached in mid-August. There was a slight decline afterward.

The data appear to offer some reasonable explanation of some of the differences that have been observed because it is known from other studies that natural field transmission of leafroll by winged aphids has taken place at different times in different seasons depending on the development of the aphid population.

Florida Test 1945-46. W. F. Porter, Donald Merriam, Joel Daigle, Stan Lightbody, Edward Humphrey, G. W. Simpson, E. L. Newdick. Interest in the Florida Test continues to increase. The 1945-46 test included slightly more than 1,200 paid samples in addition to a number of experimental samples from DDT trials at Houlton and Presque Isle. The test was the largest yet handled and taxed facilities for gassing at Aroostook Farm almost to the limit.

As in recent years, all certified Chippewa fields are entered in the test. The acreage of other varieties represents grower interest in each variety. (See Table 11.)

The readings on samples returned from Florida were by far the most satisfactory of any in recent years and actually represent, in the case of several varieties, more seed than will be needed to plant the normal certified seed acreage in 1946. This situation should result in an improvement of table stock seed which is very much needed if any progress is to be made in reducing the incidence of leafroll in the seed being planted in Maine.

Foundation Seed Plot Program. W. F. Porter, G. W. Simpson, Roger M. Cobb, Donald Merriam. Interest in 1945 in the roguing service was greater than at any time since the service was offered. In spite of difficulties at planting time, early roguing was generally possible and it is believed that in most plots, all plants derived from diseased tubers were removed before aphids became numerous.

The summer flights of the green peach aphid were considerably delayed beyond the time for such flights in recent years. This per-

mitted some delay in early harvesting operations with some increase in yields.

The results of the Florida Test indicate that there was a great deal of variation between plots, depending to some extent on geographical location but to a greater extent on other factors such as planting dates and original virus content. There is a difference also due to variety that is always important. Early roguing appears necessary to success and the quality of the roguing done will likewise influence results.

As has happened before, plots in the northern part of the State tend to be more easily handled than plots farther south, other factors being equal.

The results indicate that the aphid flight studies provide a fairly satisfactory basis for estimating early harvesting dates. Delay to mid-August was suggested in 1945 and proved, with some exceptions of course, to have been possible, particularly in early-planted plots where roguing was thoroughly done early in the season.

Table 12 presents the figures on acreage and variety for the 1945 season.

Table 12 gives the results of the Florida Test and compares them with results based on all samples entered in the test.

The roguing service in the future is to be conducted under the supervision of the Maine State Seed Potato Board.

Date of Planting. A. Frank Ross. The effect of date of planting on net necrosis was tested again in Aroostook County (see Table 13) and the study was extended to central Maine (See Table 14). Both Green Mountains and Irish Cobblers were used. Although the amount of net necrosis developing in the Aroostook Farm potatoes was small, a definite effect of planting date was apparent in the case of the Green Mountains. This was true for both strains tested and at each digging date. It should be noted that late planting and early harvest gave more net necrosis than early planting regardless of harvest date. These tubers will be replanted to determine the amount of leafroll spread in the various lots. The yield data are presented in Table 22.

None of the Cobbler samples developed any appreciable amount of net necrosis, hence no effect of planting date was discernible in 1945.

In central Maine (near Bangor) date of planting had no effect on net necrosis. The explanation may possibly lie in a failure to

plant early enough or in the extremely dry conditions that existed in that area. Yield data are presented in Table 23.

Effect of Fertilizer Practice on Spread of Leafroll. A. Frank Ross. Data on the amount of leafroll spread on certain of the Permanent Plots at Aroostook Farm were obtained again in 1945. Results in general were more erratic than in previous years. Aphids were unusually numerous in 1944 and consequently leafroll spread was quite serious. It may be that in such years other factors affecting the spread of leafroll are of minor importance. Although results were erratic there was a definite tendency for leafroll spread to be increased by increasing the rate of fertilizer application, and by increasing the proportion of phosphorus in the fertilizer (See Table 15). It was decreased by the substitution of K_2SO_4 for KCl as the source of potash and by the use of chemically pure salts. None of the various fertilizer practices had any consistent effect on the net-necrosis/leafroll ratio.

The plots planted to potatoes every year received potash in the form of KCl up to and including 1941. In 1942 and since, one half of each plot was fertilized with goods containing K_2SO_4 as a source of potash. In most cases, this change in source of potash caused a reduction in the spread of leafroll in 1944, the third year of K_2SO_4 applications.

The two strains of Green Mountains differed slightly in behavior. Leafroll spread was slightly greater and the net necrosis/leafroll ratio slightly less in the case of the Highmoor strain than in that of the Keswick. It was noted that emergence was much slower in the rows planted with the Highmoor strain. As this would be equivalent to later planting, it probably accounts for the difference in behavior of the two strains.

APHIDS AFFECTING POTATOES IN MAINE.[5] Geddes W. Simpson, Wayland A. Shands. Aphids were less abundant in 1945 than in 1944 during the early part of the season, but increased in abundance late in the season.

Wild and Cultivated Host Plants. SECONDARY HOSTS. *Biennial weeds as overwintering hosts of wingless aphids.* Observations

[5] The studies with aphids affecting potatoes and their control are made in cooperation with the Bureau of Entomology and Plant Quarantine of the Agricultural Research Administration of the U. S. Department of Agriculture. W. A. Shands, Floyd F. Smith, and T. E. Bronson are the Bureau representatives working on these problems in Maine.

carried out before spring migrations of the aphids[6] affecting potatoes took place again did not disclose overwintering of viviparous, apterous aphids on any of several species of biennial weeds.

Importance of weeds as aphid hosts when growing in waste-land. In 1945, for the third consecutive season, investigations were conducted to determine the importance of certain weeds as hosts of aphids affecting potatoes. The several species of weeds[7] were present in natural, mixed stands and altogether there were five plots, each representing a different age group or time of weed germination. The five age groups, determined by the time of final cultivation of each plot, corresponded to natural germination occurring after (1) the beginning of spring, (2) potato planting time, and after (3) the first, (4) the second and (5) the third or final hilling operation in potatoes.

There were many differences between 1944 and 1945 from the standpoint of over-all host performance of the weeds in the several age groups. For production of winged buckthorn aphids smartweed was of considerably greater importance in 1945 than in 1944, while lamb's-quarters, wild rutabaga and wild radish were of much less importance in 1945. In the case of wingless buckthorn aphids, however, smartweed was considerably less important in 1945 than the previous year, while wild radish, hemp nettle, and field sorrel were much more or considerably more important as hosts in 1945.

In the instance of the green peach aphid, hemp nettle was somewhat more important in 1945 than in 1944 from the standpoints of both winged and wingless forms. Smartweed was somewhat more important in 1945 as a host for wingless aphids of this species, but not for the winged forms. In 1945 lamb's-quarters was much more important as a host of the wingless form, but not for the winged ones.

Comparisons between the two years for the potato aphid are also of interest. Hemp nettle was considerably more important in

[6] The buckthorn aphid, *Aphis abbreviata* Patch; the green peach aphid, *Myzus persicae* (Sulz.), the potato aphid, *Macrosiphum solanifolii* (Ashm.); and the foxglove aphid, *Myzus pseudosolani* (Theob.).

[7] Wild radish, *Raphanus raphanistrum* L.; wild rutabaga, *Brassica campestris* L.; hemp nettle, *Galeopsis tetrahit* L.; smartweed, *Polygonum lapathifolium* L.; field sorrel, *Rumex acetocella* L.; ox-eye daisy, *Chrysanthemum leucanthemum* L. var. *pinnatifidum* Lecoq. and Lamotte; chickweed, *Cerastium vulgatum* L. var. *hirsutum* Fries; and plantain, *Plantago*, sp.

1945 as a host of both the winged and wingless aphids of that species; lamb's-quarters was of far greater importance as a host for both forms than it was in 1944; wild rutabaga and smartweed were considerably less important in 1945; and wild radish was considerably less important in 1945 as a host of wingless forms, but not for the winged forms.

For the three species of aphids, combined, hemp nettle, smartweed, and lamb's-quarters were much more important in 1945 than in 1944 as hosts of wingless forms, and considerably more important as hosts of the winged forms. This is of particular interest since these weeds were of relatively greater importance in this capacity during 1944 than they were in 1943. The reasons for these changes are not fully apparent, but it does show that year-to-year differences in host performance vary and that several years of study will be required to assess the full importance of each.

As in previous years weeds of age group 4 (those germinating after the second hilling of potatoes) were the most important in respect to total aphids produced. Weeds of age group 5, those germinating after the third or final hilling of potatoes, were relatively more important as hosts of the green peach aphid in 1945 than in 1944, primarily because parasites and fungus diseases affecting the aphids were later in appreciably affecting population trends of the aphid in 1945. Weeds of no importance as hosts during 1945 included ox-eye daisy, plantain, and chickweed.

Weeds as intermediate hosts of the aphids. These studies showed that winged forms of the green peach aphid developed in as little time as 19 days after colonization by alatae which had matured on wild plum, the primary host of this aphid. Much more time was required in 1945 for alatae to appear in natural colonizations of the aphid on weeds growing in wasteland than in artificial colonizations of aphids on similar weeds growing in oats.

Potatoes as a host of the aphids. Aphid population trends were followed closely in four fields of potatoes near Presque Isle. Counts were made at approximately weekly intervals between late June and the middle of August. Of particular importance is the relatively increased proportion of buckthorn aphids, except in a field planted to the Katahdin variety, and also the fact that the foxglove aphid was generally present in appreciable numbers for the first time in recent years. Over-all aphid populations on potatoes in general were smaller than those found in 1944, and the date when 100

per cent of the plants became infested was in general about 2 weeks later than in 1944.

Flight Habits and Environmental Factors. SEASONAL FLIGHT HABITS AND RELATIVE ABUNDANCE OF THE FLYING APHIDS. Eight mechanical traps were operated near Presque Isle for the fourth consecutive season.

The flight season in 1945 started later than has been the case in recent years. Heavy flights were encountered in late August and September, but the period was somewhat shorter than in 1944. While actual figures are not available, it appears that the numbers caught at the peak of the flight were not essentially different from those obtained in 1944. Total catches are expected to be considerably below the 1944 totals.

Winter Carry-Over Hosts of the Aphids and Their Relative Abundance. THE BUCKTHORN APHID. Eggs were not especially abundant on buckthorn, the primary host of the buckthorn aphid, in the spring of 1945. This was reflected in the trap catches which were light until well along into August. Field counts, however, showed large numbers present in a number of fields by mid-August. Return migrants were generally present by August 16 indicating that the flight started perhaps as early as August 10.

The first male seen was taken in a trap on August 10. The return migration evidently was very successful, because the fall egg survey showed larger numbers of fully distended eggs at each sample location than had previously been recorded on buckthorn, except at one place in 1943.

THE GREEN PEACH APHID. *General seasonal phenomena.* Aphid eggs surviving the winter on wild plum were at the lowest level yet recorded in these studies. In fact eggs were found on wild plum at only one location.

The first winged forms were taken from cages on June 12, about 2 weeks later than in 1944. Alatae continued to be produced on the wild plum at least until August 1, although the peak of the migration came late in June. Summer dispersal forms on secondary hosts were likewise late in developing, although they became quite numerous before the season was over.

The fall or return migration was rather extensive, but aphid populations on wild plum were probably not as heavy as those found in several previous years.

THE POTATO APHID. The spring survey disclosed relatively few aphid eggs on wild roses. The trap catches showed a small flight in the early part of July.

The fall survey showed far larger numbers of aphid eggs on wild roses than had been found before. However, observations indicated that many were eggs of aphids other than the potato aphid.

THE FOXGLOVE APHID. Observations have indicated that the foxglove aphid is increasing in importance as a potato pest in northeastern Maine. Early counts in various fields showed the foxglove aphid to be present in small numbers. In some instances the aphid became the dominant species on potatoes. In many instances it was present in larger numbers than had been recorded heretofore.

In spite of the rather large numbers of the foxglove aphid found during the latter part of the season observations failed to disclose the presence of many alate forms, which may account for the small number taken in traps here and in New Brunswick. The only times when alatae of this species were relatively numerous were when the spring migration occurred and again about 3 to 4 weeks later.

Observations begun in September showed that foxglove aphids could live on *Chelone glabra* L., a bog plant found growing near Mapleton. A number of plants were caged late in September and colonized with foxglove aphids from a nearby potato field. When final observations were made of these plants on November 1, two aphid eggs were found. It thus seems likely that oviparous forms, at least, matured on caged *Chelone glabra* growing under natural conditions.

The finding of foxglove aphids on *Chelone glabra* may prove of great importance in helping to answer some of the perplexing questions about the life history of this aphid in Maine. Not much is known of the distribution of *Chelone glabra* at present but, being a bog plant, it is likely to be found over almost the whole area. If it proves to be an important primary host of the foxglove aphid, one reason for the widespread distribution of the foxglove aphid early in the season will have been found.

ABUNDANCE OF APHID EGGS ON OVERWINTERING HOSTS. *Spring survey.* Aphid eggs were found to be virtually absent on wild plum, even fewer than in the fall of 1944 being found. Some additional stations for sampling wild plum were established at this time in

order to take in potato districts north of Presque Isle.

Eggs on buckthorn were again fewer in the spring than they had been in the fall before. This was true at every station sampled and is a pretty clear indication that there is a definite loss of aphid eggs during the winter.

Eggs on wild roses were likewise fewer in the spring than in the preceding fall. In fact, eggs were found at only one location in the spring.

The lack of eggs on primary hosts was reflected in the early-season scarcity of aphids over the area. Again this season there was a fairly definite correlation between the numbers of aphid eggs on primary hosts and the size of the early-season aphid populations. This relation did not hold later in the season, except in a general way, in that, had populations been large in the spring, much more damage than actually was sustained might have been expected in August and September. The aphid population developed late enough, and was relatively small enough, to permit growers to produce much more seed of foundation quality than has been produced in nearly ten years.

Fall survey. Aphid eggs were again abundant on primary hosts in the fall of 1945. Evidently conditions during the fall migration period were generally favorable. Fungus diseases were far less prevalent than the fall before.

Aphid eggs on wild plum were found at 21 out of 26 locations, although they were numerous at only 4. While it is known that other aphids besides the green peach aphid lay eggs on plum, it seems safe to assume that stem mothers should be easier to find in the spring of 1946 than they were at the same time in 1945. In fact, the outlook for the season is definitely less satisfactory from the standpoint of the potato grower than it has been since 1943.

Aphid eggs on buckthorn were more numerous in the fall of 1945 at all but one station, than at any time since records have been made. While some loss during the winter is to be expected, spring migrants are likely to be more abundant than usual and, if summer conditions are at all favorable, populations in potatoes, at least near buckthorn, may well reach damaging proportions in August.

The situation on rose is less clear cut. While eggs were numerous in the fall of 1945, observations showed that many of them are of species other than the potato aphid.

Insect Traps in Central Maine. G. W. Simpson, R. M. Cobb,

Dorothy Wentworth. Through the cooperation of four growers, it was possible to follow the movement of winged aphids at four locations in central Maine. Since this was the first attempt in this area to determine early harvest dates by a study of the aphids caught daily in aphid traps, the results are tentative and do not warrant definite conclusions.

The trap records suggest that flights of aphids in this area were much less heavy than in the areas of Aroostook County where similar traps were in operation. However, flights of the green peach aphid started somewhat earlier in central Maine than in Aroostook, a factor that may help to explain the greater spread of leafroll in central Maine.

The results of the Florida test indicate that, in 1945 at least, much smaller flights of the green peach aphid may have been needed in central Maine to bring about excessive spread of leafroll than has been the case farther north. The finding of primary leafroll in some fields early in August may indicate a very early flight of green peach or of foxglove aphids, which was not recorded in the trap catches.

After trap records become available for several years, it should be possible to correlate them with the information obtained from the Florida test and to arrive eventually at a point where reliable information can be made available to all growers wishing to early harvest at a time when the maximum yield consistent with relative freedom from virus diseases may be obtained.

From the results obtained in 1945 it appears likely that early planting in central Maine is of even more importance than it is farther north and that satisfactory early harvesting dates may be earlier than will be the case in Aroostook.

Control of Aphids on Potatoes and the Spread of Leafroll. Houlton, Maine. T. E. Bronson, F. F. Smith, W. A. Shands, G. W. Simpson. BIOLOGICAL DATA. Experiments in aphid control were continued for a sixth season in the Houlton area. Emphasis in 1945 was placed on DDT and its effect on yield and on the spread of leafroll. Included in addition to DDT in some of the tests were nicotine, derris and benzene hexachloride.

Four species of aphids are involved in this area. Of these the green peach aphid is of paramount importance in the transmission of leafroll. Direct feeding damage is usually due to either the potato or the buckthorn aphid, although conditions differ from

year to year and from field to field. The foxglove aphid is usually of minor importance, having been recognized for the first time at Houlton in 1945.

Aphid infestations were very low during the early part of the season. However, in late July and during August infestations increased to such proportions that severe damage to potato plants resulted in many fields.

At its peak the 1945 aphid infestation in the fields near Houlton, where experiments with insecticides were performed, was about one third heavier than in 1944. At the peaks of infestations during the six years of study, 1943 was the low year, 1945 was 21 times as heavy, 1944, 15 times as heavy, 1942, 6 times as heavy, 1941, 3 times as heavy, and 1940 was the worst year, the infestation being 100 times the 1943 figure.

Two aphid traps were employed at Houlton to determine the movement of winged aphids near the experimental plots. One trap in an exposed position caught nearly 5 times as many aphids as the other which was near the field used in the leafroll experiment. The data on trap catches were used to determine the date when early harvesting should be done. It was decided that August 14 was the last safe date for pulling tops, a decision subsequently proven about right by the Florida test.

APHID AND LEAFROLL CONTROL. *Houlton, Maine.* For the application of most of the sprays in the first experiment and of some of the sprays in the other experiments, a tractor-mounted sprayer was designed and largely built by J. W. Slosser of the Soil Conservation Service, U. S. Department of Agriculture, working in cooperation with the Maine Station. This sprayer was especially designed for insect control.

For the application of the aerosols the Slosser sprayer was employed, using special copper tubes and aerosol dispersing nozzles attached to the fixed boom of the sprayer. The nozzles were fixed at about the same positions as were the regular nozzles. About 20 pounds of aerosol per acre were applied by this means.

At some of the farms where tests were conducted, traction sprayers were used, at other farms tractor-mounted sprayers were available.

All dust mixtures were applied with a tractor-mounted six-row duster operated from a power take-off. The duster applied about 35 pounds of dust per acre.

FIG. 1. Slosser Tractor-Mounted Sprayer. Note vine lifting rods and the four nozzles per row. Houlton, Maine, July, 1945.

Results in 1944 had shown little promise of controlling leaf-roll through aphid control. The work in 1945 was designed to repeat this phase of the experiment and at the same time to determine the effectiveness of a number of different insecticide formulations against 4 species of aphids.

The field chosen for this experiment was divided into plots about a quarter of an acre in size. There were 4 replications of each treatment. The treatments included an aerosol, a DDT suspension, a DDT emulsion, a DDT dust, a derris suspension, and a check.

Aphid counts were made on 3 occasions during the summer using 25 plants picked at random in each replication, or a total of 300 leaves for each treatment. The reduction in the aphid infestation is presented in Table 16. Very satisfactory reductions were obtained with the DDT formulations, the derris being considerably less effective.

DDT in the form of an aerosol, suspension, or emulsion was superior to DDT as a dust, and all were considerably superior to a derris suspension.

In spite of the degree of aphid control obtained, the results of the Florida test (Table 17) indicate that the treatments did not provide protection against incoming winged aphids. Incidentally, these results also indicate that the use of a herbicide for early

harvesting does not provide adequate protection against leafroll spread unless it is applied earlier than is necessary when tops are pulled, since in another experiment, where tubers were taken at about this same time, no leafroll was found in the sample.

The check plots had a lower leafroll reading than did the treated plots, yet all plots were equally exposed to incoming winged aphids. The insecticides must have some effect on the plants that makes them more attractive to aphids or that permits more rapid penetration of virus to the tubers.

These data show rather conclusively that when seed stock with a low disease content is planted for seed purposes, a much greater spread of the leafroll virus may be expected as a result of insecticide applications for control of aphids than will occur when no such applications are made, except in those cases where foliage is destroyed before aphid dispersal commences.

In the 1945 experiments the plots were exposed to the very beginning of the aphid flight before the herbicide was applied. It was thus demonstrated that the residual effect of the insecticides used upon incoming winged aphids was not complete enough to prevent some transmission of leafroll.

In another test on larger but unreplicated plots, benzene hexachloride and DDT dust mixtures resulted in highly satisfactory aphid control. Increases in yield varied greatly from treatment to treatment. In all but one instance they were substantial. (See Table 18.)

Tubers were taken from 3 plots on August 10, again on August 30, and finally on September 27, in order to determine the spread of leafroll. The results are given in Table 19.

The longer the delay in digging tubers the greater was the amount of leafroll for all treatments, especially the insecticidal treatments.

Tests were conducted also in six fields on outlying farms using various mixtures of DDT applied with the grower's equipment. As in the other fields, the Katahdin variety was planted, except in one instance as noted in Table 20.

It is important to notice the variation in the results obtained. These variations are due to differences in aphid and flea beetle infestations, to soil fertility, to date of planting and perhaps to other more obscure factors. However, increases in yield were obtained in all instances. All DDT preparations—the various

emulsions and suspensions—resulted in increases in yield ranging from 1 to 38 per cent and averaging 18 per cent.

Tubers were taken from the emulsion and check plots on two dates at three farms and tested for leafroll content in Florida. The data (Table 21) indicate considerable spread of leafroll in all plots, and again show more disease in treated than in untreated plots.

Conclusions. It is now an established fact that practical control of potato aphids will result in substantial increases in yield. When employed as an aerosol, a spray, or a dust mixture DDT appears to offer a better control of aphids than has been possible in the past. It is now quite evident that, regardless of the degree of aphid control maintained during June and July, it is during the critical period in August that incoming disease-carrying winged aphids must be almost completely controlled if leafroll is to be held within tolerable limits. Even a light infestation of such dispersing aphids readily settling on well sprayed or dusted green-foliaged potatoes is capable of transmitting leafroll in such amounts that the protected foliage may be infected with much more of the disease organism than unsprayed aphid-damaged plants.

It is hoped that in time leafroll may be controlled from a practical standpoint through the cooperative efforts of all growers (perhaps on an area basis) by conscientiously following a program, including the purchase of good seed stock, isolation of fields producing seed potatoes, roguing of diseased plants, aphid control, and early harvesting of seed stock. Only by the combined efforts of growers following such a program can the control of leafroll be accomplished.

Presque Isle, Maine. Floyd F. Smith and P. M. Lombard.[8] Experimental plots were established at Aroostook Farm, Presque Isle, to compare the aphicidal action of DDT in aerosols, emulsions, and suspensions when combined with fungicidal materials. Information was obtained relative to (1) reduction in number of aphids, (2) prevention of late blight infection, (3) visible foliage injury, (4) crop yields, and (5) comparative rate of spread of the virus diseases.

Green Mountain and Mohawk potatoes were included in the

[8] Representatives, respectively, of the Bureau of Entomology and Plant Quarantine and the Bureau of Plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture.

3 experiments. Materials except the DDT aerosol were applied with a six-row power take-off sprayer having 4 nozzles per row.

There were 8 treatments in Experiment 1, including Bordeaux mixture, check plot, DDT aerosol, 3 DDT emulsions in Bordeaux, a DDT suspension in Bordeaux, an emulsion in tribasic copper sulfate, and an emulsion in the fungicide disodium ethylene bisdithiocarbamate.[9]

There were 4 treatments in Experiment 2, using different solvents for the DDT which was applied as an emulsion in Bordeaux.

There were 4 treatments in Experiment 3, including Bordeaux, Bordeaux with 2 wetting agents, and Bordeaux with a DDT emulsion not included in the other experiments.

Applications of each treatment were made at weekly intervals and continued until frost. In Experiment 1 the first application was made July 3 and a total of 12 applications were made. The first application was made July 20 to plots in Experiments 2 and 3 and a total of 10 applications were made during the season. Approximately 100 gallons of spray was applied per acre.

There was no evidence of plant injury in any of the plots except in one of the emulsion plots where some injury was evident around flea beetle feeding punctures. This injury is believed due to the solvent used in making this particular emulsion.

Flea beetles and Colorado potato beetles were easily killed in all the plots where DDT was used.

Aphids were kept at a low level on all plots receiving DDT. Reductions of the buckthorn aphid on August 23 ranged from 94 to 99 per cent as compared to check plots. Reductions of the green peach aphid ranged from 90 to 98 per cent, while that of the potato aphid was only 51 to 85 per cent. The potato aphid appears to have some resistance to DDT.

In general a DDT emulsion in Bordeaux was a less effective aphicide than the same emulsion in tribasic copper sulfate or in the fungicide disodium ethylene bisdithiocarbamate.

In Experiment 1 all treatments resulted in increased yields. The yields from the best treatments were as follows: Checks (290 bushels), di- and tri-methylnaphthalene† emulsion in disodium ethylene bisdithiocarbamate (457 bushels), di- and tri-methylnaphtha-

[9] Dithane is a commercial product containing this chemical.

† Velsicol AR-60 is a commercial product containing this chemical.

lene emulsion in tribasic copper sulfate (449 bushels), DDT suspension in Bordeaux (434 bushels); di- and tri-methylnaphthalene and xylene emulsion in Bordeaux yielded 404 and 396 bushels respectively while another methylated naphthalene* emulsion yielded 375 bushels; the aerosol also yielded 375 bushels.

Tubers harvested on two different dates in August and at digging time in October indicated that infection with leafroll was temporarily delayed by the treatments in Experiment 1. However, at the time of the final harvest the infection in treated plots generally exceeded that in the check, even though the regular applications of insecticides were continued until frost. Mosaic infection was also greater in tubers from treated plots than from check plots.

All combinations of DDT and the fungicides Bordeaux, tribasic copper sulfate or disodium ethylene bisdithiocarbamate were apparently satisfactory in preventing serious late blight infection in these experiments.

TRANSLOCATION OF DDT TO POTATO TUBERS. B. E. Plummer, Jr., R. H. Carter.[10] It is known that DDT is toxic to animals when fed in sufficient quantities. Considering the possibility of DDT being translocated to potato tubers from the tops receiving DDT in the form of dust or spray, it was decided to analyze the tubers chemically for the presence of DDT. After some preliminary experimental work with methods, the total organic chlorine method was decided upon as the one most satisfactory at the present time.

The DDT molecule is one half chlorine and thus the amount of DDT is calculated by multiplying by two the total organic chlorine found in the tubers.

Potato tubers were used from a plot sprayed six times with Bordeaux mixture 8-6-100 containing 2 pounds of 50 per cent DDT in the 100 gallons of spray mixture and from a plot sprayed six times with a spray mixture containing 4 pounds of tribasic copper sulfate and 2 pounds of 50 per cent DDT in 100 gallons of water. Tubers were used also from check plots receiving the same amounts of copper but no DDT. The unpared potatoes were washed,

* P.D. 544 B is a commercial product containing this chemical.

[10] The analyses made at Beltsville were by Mr. R. H. Carter, Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine.

dehydrated, extracted with benzene and analyzed for DDT by determining the total organic chlorine content.

Tubers from the check plots were found to contain 0.17 part organic chlorine per million. This amount, when expressed in terms of DDT, is equivalent to 0.34 part per million.

The tubers from the plots sprayed with DDT were found to contain 0.16 part organic chlorine per million equivalent to 0.32 part per million of DDT. As the small organic chlorine content of the tubers from the plots sprayed with DDT was not greater than that from the check plots, it seems reasonable to assume that none of the organic chlorine was from DDT. Under the conditions of this experiment and the methods used in preparing and analyzing the samples, the results indicate no translocation of DDT from the tops to the tubers.

Chemical and colorimetric analyses were made at Beltsville on tubers from plots at Presque Isle that had received totals of 6 pounds of DDT in emulsion, 12 pounds in aerosol or 24 pounds in suspension during the season. These analyses indicated that no DDT was present. Biological tests with mosquito larvae, which will show the presence of DDT in as low concentration as 0.25 part per million, confirmed the chemical tests.

INGESTION STUDIES WITH POTATOES FROM PLOTS TREATED WITH DDT. John S. Getchell. The question has arisen as to the possibility of translocation of DDT from the sprayed or dusted potato tops to the tubers, and of DDT poisoning as a result of eating such tubers. Since DDT is toxic when ingested in appreciable amounts, a feeding experiment was planned.

Potato tubers were used from a plot sprayed six times with Bordeaux mixture 8-6-100 containing 2 pounds of 50 per cent DDT in the 100 gallons of spray mixture, and from a plot sprayed six times with a spray mixture containing 4 pounds of Basi-cop and 2 pounds of 50 per cent DDT in 100 gallons of water. These were known as "Potatoes A." Potatoes were also used from check plots receiving the same amount of copper but no DDT. These were known as "Potatoes B." The potatoes were washed but not peeled, dehydrated, and ground.

The test animals used were 18 guinea pigs weighing between 350 and 400 grams. These were divided into 3 groups of 6, individually isolated, and designated as group 1, 2, and 3.

To group 1 was fed a mixture of 3 parts "Potatoes A" and

1 part basal ration. To group 2 was fed a mixture of 3 parts "Potatoes B" and 1 part basal ration. To group 3 was fed basal ration containing 100 mg. per Kg of Dichloro Diphenyl Trichloroethane (DDT). The diet of all three groups was supplemented with green leafy vegetable together with ascorbic acid to prevent vitamin C deficiency.

The feeding experiment was conducted for two months. During this time the animals were observed for loss of weight and neurologic symptoms. At the end of this period a final weight check was made and the guinea pigs killed. A post-mortem was conducted and sections of liver and kidney were removed for microscopic study.

On observation throughout the feeding period no neurologic symptoms were observed. A constant gain in weight was recorded in all guinea pigs with an average increase at the end of the period of 97 grams.

On post-mortem examination all organs were normal and healthy. Microscopic examination of sections cut from the livers and kidneys were found normal and showed no indication of fatty degeneration.

From the observations and examinations of the animals used for this experiment, there was no indication that the sample of potatoes from the DDT sprayed stock caused any harmful effects when used as food for guinea pigs. It was of interest to note that the basal ration containing 100 mg. per Kg of DDT also caused no harmful effects when fed to the control animals.

ERADICATION OF WEEDS PARTICULARLY IMPORTANT TO POTATO GROWERS. G. P. Steinbauer, F. H. Steinmetz. Certain weeds have particular significance to potato growers in that they not only reduce yields by direct competition with the crop plants for nutrients and sunlight but that they also contribute to the prevalence of certain potato diseases. They do this by serving as breeding, overwintering and feeding plants so necessary for the development of aphids. The latter act as carriers of many potato diseases, particularly virus diseases.

Methods of eradicating the overwintering host plants, wild plum, wild rose and dwarf buckthorn and the feeding host plants, kale, wild rutabaga, smartweed, hemp nettle and daisy are presented in Miscellaneous Publication 602 of the Maine Agricultural Experiment Station.

Additional experiments carried out since the above bulletin went to press indicate that the new hormone type herbicides such as 2,4-D preparations also may be used to control the woody plants listed above. Used in concentrations of one part 2,4-D to 600 of water they produced defoliation and killing back of the wood in the parts above ground. Observations need to be continued to determine whether or not resprouting will occur.

STEM-END BROWNING. *Date of Planting.* A. Frank Ross. On Aroostook Farm, late planting resulted in more stem-end browning in Green Mountains than did early planting (See Table 22). In the case of the Highmoor strain (resistant to stem-end browning) the difference between early and late planted crops was small, but nevertheless a trend was indicated at the early and medium digging dates. When the potatoes were allowed to grow until killed by frost (September 18) and then dug, the early planted lots gave slightly more stem-end browning than did those planted later. In the case of the Keswick strain, those lots planted June 12 uniformly gave the highest stem-end browning readings, but only in the case of the earliest dug samples was there a progressive increase in disease incidence with the later planting dates. There was no apparent correlation between the length of time between planting and harvest dates and the amount of stem-end browning. In the case of Irish Cobblers the date of planting had no effect on the amount of stem-end browning.

In the central Maine plot, the Highmoor strain of Green Mountains behaved in a manner almost identical with the behavior of the same strain on Aroostook Farm. (See Table 23.) However, the average amount of stem-end browning was less and the actual differences among lots were small. The amount of stem-end browning in the central Maine Cobblers was quite small and no trend was apparent.

In respect to yield it is apparent that in practically every case the earliest planted lots gave the best yields. A progressive decrease in yield resulted from progressively later plantings. This was true even in central Maine where a severe drought occurred during a large part of the growing season.

Date of Harvest. A. Frank Ross. On Aroostook Farm, those plots where the tops were killed September 5 were lowest in stem-end browning (after storage) in the case of both strains of Green Mountain (Table 22). Apparently either very early or very late

digging results in more stem-end browning. In the case of Irish Cobblers, the later the date of harvest, the greater was the amount of stem-end browning in the stored crop. The differences, however, were small.

In central Maine the date of harvest had very little effect on the amount of stem-end browning developed in storage (Table 23).

Susceptibility of Irish Cobblers to Stem-End Browning. A. Frank Ross. Irish Cobblers were obtained from five foundation growers and compared for susceptibility to stem-end browning. After storage at 50° F. for 100 days or more the crop from the 5 lots contained 18.7 per cent, 22.7 per cent, 24.0 per cent, 20.2 per cent, and 26.5 per cent stem-end browning respectively. Hence, it appears that all were approximately equal in susceptibility to this disease.

Susceptibility of Green Mountains to Stem-End Browning. A. Frank Ross. The Highmoor strain and the Minnesota lot continued to be considerably more resistant to stem-end browning than the Keswick strain. Several additional foundation lots were tested in 1945 and of these, only the Keswick strain was highly susceptible. The data to date indicate that the Keswick strain is the only highly susceptible strain that is grown extensively in Maine.

Effect of Continued Propagation of Green Mountains in Maine on Susceptibility to Stem-End Browning. A. Frank Ross. A comparison was made of the relative amounts of stem-end browning in a Green Mountain strain grown for various lengths of time in Maine (Table 24). Seed obtained directly from Minnesota produced only slightly less stem-end browning than the same strain after one year's propagation in this State. The difference is so small that it may not be significant. There was no further change in susceptibility with continued propagation in Maine. It should be noted also that the Highmoor strain, which has been propagated in this area for many years, is no more susceptible than the Minnesota lot. Each produced only one fourth to one third as much stem-end browning as did the Keswick strain. Except for the possibility of a slight increase in susceptibility the first year of introduction, it appears fairly certain that a resistant strain is stable in that its susceptibility to stem-end browning does not increase from year to year.

Transmission of Susceptibility to Stem-End Browning. A. Frank Ross. Replanting of the 1944 tuber graft progeny indi-

cated that less than 20 per cent of the grafts resulted in transmission of susceptibility to stem-end browning. There were a few, however, where definite evidence of transmission was obtained. In the case of inarch grafting, the percentage of successful grafts was somewhat higher. Of the total number replanted 39.4 per cent of the units showed definite evidence of transmission and 15.0 per cent of the units showed evidence of probable transmission.

Inarch grafts made in 1945 provided some evidence of transmission of susceptibility as judged by the stem-end browning in this year's crop. Plants of the Keswick strain were used as the scions. Where the Minnesota lot was used as stock, the grafted units produced 25.7 per cent stem-end browning as compared to 16.1 per cent in the tubers from the nongrafted control. About 20 per cent of the grafted units showed a definite indication of transmission. Where plants of the Highmoor strain were used as stocks, the grafted units produced 25.5 per cent stem-end browning and the control units 20.0 per cent. Only 15 per cent of the units gave evidence of transmission. While the data on the 1945 grafts may not be significant, the complete data on the 1944 grafts provide definite evidence that transmission of susceptibility to stem-end browning occurs in some of the grafted plants. It is clear, however, that in a majority of the cases where actual union of stock and scion occurs, no transmission of susceptibility takes place. Double grafts, where plants of the Keswick strain were grafted to Katahdin (or seedling 41956) and the latter to Green Mountains (resistant strain) gave no transmission of susceptibility to stem-end browning.

Late Blight and Early Blight. Reiner Bonde, E. R. Tobey, B. E. Plummer, Jr. Late blight was prevalent over most of the Aroostook County potato area in 1945, and caused a considerable amount of loss to the potato industry. The disease appeared in the fields at an early date. It was found in four potato cull piles on June 15. When these cull piles were visited again on July 4 the disease already had spread into the neighboring fields. In one case 85 per cent of the plants in a field nearest an infected cull pile were slightly infected with late blight when carefully examined on July 6. Few farmers at that time realized that late blight already was present in their fields and many had not begun their spraying

operations.[11] The dry weather that prevailed later in the season curtailed the spread of late blight and prevented even larger losses from the disease.

Control of Early Blight and Late Blight with Fungicides in Combination with DDT. Reiner Bonde, Everett Snyder. Four organic fungicides were compared with Bordeaux mixture and Basic Copper Sulphate in 1945 regarding their ability to control early and late blight. These fungicides were applied with and without DDT and data secured regarding the relative control of flea beetles and aphids.[12] Data were obtained also on yield as affected by the fungicides alone and in combinations with DDT. (See Table 25.)

Bordeaux treated plots yielded slightly less than those treated with the other copper fungicides, namely, Basic Copper Sulphate and Basic Copper Arsenate. Plots treated with Fermate, an organic fungicide containing no copper, gave the lowest yields for this experiment. In contrast, Karbam Z, another organic fungicide without copper, was one of the best, and Dithane, also, gave good control.

The addition of one pound of active DDT (2 pounds of 50 per cent) to 100 gallons of fungicidal spray material increased the yield rate as much as 33 barrels per acre, or 26 per cent. DDT appeared to be especially effective when added to the neutral copper and the non-copperous organic fungicides.

The data pertaining to the control of early blight, late blight, and the injury caused by flea beetles and aphids are summarized in Table 26. The two neutral coppers and Fermate were the least effective in controlling early blight and Karbam Z was the most effective. The addition of DDT increased the control of early blight for most of the fungicides as is indicated by the larger protective coefficient shown where it was added. DDT when used

[11] Field observations have shown that the failure to control late blight often results because the disease has already spread into the field before the spray operations have begun.

[12] The fungicides were applied with a motor driven power sprayer maintaining 300 pounds pressure and mounted on a truck, and equipped with a hose long enough to reach the different plots. Each plot was four rows wide and 25 feet long. Yields and disease and insect control data were taken from two center rows of each plot. There were nine replications for each treatment.

alone appeared to possess very little or no value for the control of early blight.

As measured by the Protective Coefficient of the different fungicides (see Table 26) Bordeaux, Basic Copper Sulphate, Basic Copper Arsenate, and Dithane were very effective for the control of late blight and Fermate and Karbam Z were rather poor. The addition of DDT increased the control of late blight for plots sprayed with Bordeaux, Basic Copper Sulphate, Basic Copper Arsenate, Karbam Z and soap, and Dithane.

Much of the yield increase derived from the use of DDT in the spray fungicide appeared to be a result of the control of flea beetles. The non-copper containing fungicides, namely Fermate, Karbam Z, Karbam Z and soap, and Dithane were less effective in controlling flea beetles than were Bordeaux and Basic Copper Sulphate. Dithane, especially, appeared to be a poor repellent of flea beetles and its protective coefficient was only 65. The addition of DDT greatly increased the effectiveness of all of the fungicides for flea beetle control, the value of the protective coefficients in all cases being significantly higher than for the same fungicides without this insecticide.

The control of aphids also is an important factor influencing the yield rate of potatoes in Maine. The Katahdin variety, used in these experiments, is especially susceptible to aphid injury. Field observations have indicated that the aphid population often is greater in fields sprayed with Bordeaux than in those receiving applications of the neutral copper or dust fungicides. In the tests for 1945 there were significantly more aphids in the plots sprayed with Bordeaux than there were on the plots that were sprayed with Basic Copper Sulphate, Karbam Z or Karbam Z and soap. (See Table 26.) The unsprayed controls and the plots sprayed with Basic Copper Arsenate harbored more aphids than the plots that received Bordeaux. The plots that received the Fermate and the Dithane spray applications harbored slightly fewer aphids than did the Bordeaux control plots.

Comparison of Different Dusts and Combinations with DDT. Reiner Bonde, Everett Snyder. SMALL TEST PLOTS. This experiment was conducted with the Mohawk variety, using four row plots each 25 feet in length and replicated 5 times. The plots re-

ceived seven fungicidal applications during the season.[13] The dust was applied with a small hand duster outfit. The sprays were applied with a small motor driven sprayer mounted on a truck and equipped with nozzles and a hose of sufficient length to reach the plots.

Observations were secured on the presence of early and late blight and the degree of injury caused by flea beetles and aphids. Yield data were secured from the two center rows of each plot. (See Table 27.) The potatoes sprayed with Bordeaux gave the lowest yield rate in comparison with the other fungicides included in the experiment. This low yield rate cannot be attributed to a lack of the control of late blight and early blight or to injury caused by flea beetles and aphids. Bordeaux spray had a depressing effect on the growth of the potato plants which resulted in a retardation of maturity and a resulting reduction in yield rate.[14] It should be noted also that the addition of DDT to the Basic Copper Sulphate dust increased the yield rate 17 to 27 barrels per acre. Furthermore, three per cent DDT added to the fungicide increased the yield six barrels per acre more than did the addition of one per cent DDT when a nine per cent Metallic Copper Dust was used.

The increased yields that resulted from the addition of DDT to the dust fungicides was caused largely by a reduction in the number of flea beetles and aphids that attacked the plants. The protective index for flea beetle injury varied from 108 per cent to 119 per cent for the dust plots that received DDT compared with 67 per cent to 90 per cent for the control plots that did not. Bordeaux, it will be noted, gave good control against flea beetle injury and the two diseases.

The field observations indicated that DDT added to the fungicide reduced the aphid population from 70 per cent to 80 per cent, the protective coefficient for the control of aphids being 129 and 125 per cent respectively for the dusts containing one per cent DDT

[13] The applications were made July 18, and 27, August 3, 11, 18, 25, and September 5. The amount of dust applied per application varied from 20 to 50 pounds.

[14] It should be noted that the Bordeaux fungicide gave reduced yields in other spray experiments conducted in 1945. The plots sprayed with Bordeaux were growing actively when killed by frost September 16. The yield rate would have increased materially provided the time of killing frosts had been delayed. In this event the Bordeaux plots possibly would have surpassed those with the other treatments.

and 133 per cent for the dust that contained three per cent DDT. The protective coefficient for the dusted plots that did not receive DDT varied from 89 per cent to 98 per cent. Of special interest is the fact that the addition of DDT increased the fungicidal value of the Basic Copper Dusts. One per cent DDT added to a 4 per cent Metallic Copper Dust increased the protective coefficient for late blight control from 85 per cent to 93 per cent and for early blight control from 69 per cent to 93 per cent.

Three per cent DDT increased the fungicidal value of the dust materials to a greater extent than did the addition of one per cent DDT. The protective coefficient for late blight control comparing the one and the three per cent DDT dusts was increased from 99 to 107 per cent and for the control of early blight from 93 per cent to 103 per cent.

In these plots the Copper Lime dust was a less desirable fungicide than were the Cuprocide and the Basic Copper Sulphate talc dusts. It is apparent that rather low copper-containing dusts may be used successfully, especially if DDT is added.

LARGE PLOTS AND TRACTOR EQUIPMENT. An experiment was conducted in 1945 also on large plots comparing a number of dust fungicides and combinations of these materials with DDT regarding their effect on the yield rate and the control of late blight, flea beetles, and aphids. The fungicides were applied with a tractor power duster which applied from 30 to 40 pounds of material per acre. Several applications were made during the season.

The 7 per cent Basic Copper Sulphate Talc dust did not satisfactorily control late blight and flea beetles in this experiment and the values of the protective coefficients were low, being 72 and 86 per cent respectively. (See Table 28.) The inability to control late blight and flea beetles was reflected in a low yield rate of only 101 barrels per acre. In contrast, the same fungicide containing 9 per cent metallic copper and 3 per cent DDT gave good control of late blight and flea beetles and greatly reduced the number of aphids. The effective control of disease and insects was reflected in the highest yield rate for any material used in this experiment, namely, 131 barrels per acre.

A Copper Lime dust with 9 per cent Metallic Copper or a dust with 3 per cent Karbam Z and 3 per cent DDT were not as efficient fungicides as were Bordeaux mixture and Basic Copper

Sulphate used as a spray and as a dust containing 9 per cent Metallic Copper and 3 per cent DDT.

Although Bordeaux gave good control of late blight and flea beetles, the yield rate was rather small in comparison with the other fungicides. This possibly was due to the fact that aphids were extremely abundant on the plots that received this treatment. The aphids caused a marked distortion and some killing of the leaves which no doubt resulted in a reduced yield rate.

There were more aphids in the plots sprayed with Bordeaux than in the plots sprayed with Basic Copper Sulphate or those dusted with Karbam fortified with DDT. The addition of DDT to the Basic Copper Talc dust and to the Karbam Z dust fungicides increased their value for aphid control as measured by the Protective Coefficient (see Table 28).

Comparison of Dust and Spray Fungicides Applied to Katahdins with Tractor Power Equipment. Reiner Bonde, Everett Snyder. An experiment was conducted in 1945 comparing Bordeaux and Basic Copper Sulphate spray fungicides with a Copper Lime and a Yellow Cuprocide Talc dust fungicide. The dust fungicides already were mixed when purchased and were representative of the materials commonly used in certain areas of Aroostook County. The spray and the dust fungicides both were applied with tractor power equipment. The plots received seven applications of the fungicides throughout the season.

In this test Bordeaux gave the best control of late blight, only a slight trace of the disease developing in the plots treated with it. (See Table 29.) Basic Copper Sulphate spray also gave very good control of late blight. The dust fungicides, on the other hand, did not give as good control of the disease which is shown by the lower value of the protective coefficient. This lack of late blight control manifested itself in lower yield rates.

Yellow Cuprocide dust containing only 4.1 per cent metallic copper did not give satisfactory control of late blight and was a less effective fungicide than the Copper Lime dust containing 9 per cent metallic copper. The question naturally arises as to whether better control of the diseases would have resulted provided a higher copper content had been present in the Cuprocide Talc dust.[15]

[15] It is realized that many growers in Aroostook County secure ideal control of the diseases with the different dust fungicides.

The first application of the fungicides was made July 19, at a time when the plants were rather large and when a trace of late blight already was present in the field. The dust fungicides possibly would have given better control of late blight if the first applications had been made at an earlier date and at more frequent intervals.

Comparison of Different Copper Fungicides in the Katahdin Variety. Reiner Bonde, Everett Snyder. Four copper fungicides were compared with Bordeaux regarding their effect on yield rate and on control of late blight, early blight, and flea beetles.

Bordeaux mixture gave the best control of the blight diseases and flea beetles. (See Table 30.) In spite of this fact, the lowest yields were secured with the use of this fungicide. The best yield rates were obtained with Cuprocide. However, the differences between the yields secured by the different fungicides were in no case great enough to be considered as being highly significant for this experiment.

Non-Copper Containing Fungicides. Reiner Bonde, Everett Snyder. An experiment was conducted at Aroostook Farm in 1945 comparing eight organic spray materials with Bordeaux mixture and with Basic Copper Sulphate regarding effect on yield rate, on control of the two blight diseases, on control of flea beetles, and on control of aphids.[16]

Plots sprayed with Karbam Z (without soap) a zinc carbamate, non-copper containing material, yielded slightly more than those sprayed with Bordeaux Mixture or any other material included in the experiment. (See Table 31.) This was in spite of the fact that this material did not give very good control of late blight and flea beetle injury. It, however, was superior to all the other fungicides regarding the control of early blight and the aphid population was relatively small.

Plots sprayed with Zerlate, also a zinc carbamate fungicide, and similar to Karbam Z, gave relatively large yields in this experiment. This fungicide gave fairly good control of late blight but was inferior to Karbam Z for the control of early blight and flea beetles.

Dithane, another carbamate material, was an excellent fungi-

[16] The applications of spray material were made with a small motor-driven outfit mounted on a truck and equipped with a hose with nozzle of sufficient length to reach the different plots.

cide for early blight and late blight, being only slightly inferior to Bordeaux in this respect, and the yield rate for plots treated with it was slightly less. Dithane, however, was a very poor insecticide from the standpoint of the control of flea beetles. This is a serious defect in Dithane and in some of the other organic spray materials.

Fermate, which is an iron carbamate, was a rather inferior fungicide and insecticide and the yield rate for plots treated with it was relatively low. The non-copper containing materials Phygon and Puratized, although possessing a considerable degree of fungicidal property, apparently are not suitable for spraying potatoes at the concentration used here and the yield rate for these plots was less than for the unsprayed controls. Neither of these materials gave adequate control of flea beetles.

Isothan Q 15 proved of very little fungicidal or insecticidal value in this experiment. The yield rate on plots treated with it was only slightly better than for unsprayed controls.

None of the materials used for spraying potatoes in this experiment were in combination with insecticides or are generally considered as possessing insecticidal properties. However, it was observed that the different spray treatments differed regarding the relative number of aphids that were present. There were fewer aphids on the plots sprayed with Basic Copper Sulphate than on the plots that received the other fungicides. Aphids were not too abundant on the plots sprayed with Karbam Z, Karbam Z and soap, Phygon and Puratized. They were very abundant and caused a considerable degree of damage on the unsprayed controls and on the plots sprayed with Bordeaux, Zerlate, Fermate, Dithane, and Isothan.

The data secured from these experiments indicate that certain of the organic compounds have distinct fungicidal properties for the control of early and late blight of the potato. These materials, however, in most cases do not repel flea beetles, which is a serious drawback. (Some of the neutral coppers also have not effectively controlled flea beetle injury.)

Treatment of Potato Refuse Heaps to Prevent Spread of Late Blight. G. P. Steinbauer. Cyanamid dust, napthas answering to the specifications for "Stoddard's Solvent," and dinitro phenol diesel oil preparations such as "Dow 66 Improved" and Weed Killer 75 (now "Sinox General") were used effectively to treat potato refuse heaps so as to kill sprouts and tubers. Other methods

have been described in Maine Extension Bulletin 331 and Maine Agricultural Experiment Station Bulletin 434.

Cyanamid dust applied generously so as to cover the sprouting tubers makes an effective treatment. However, it can be applied in sufficient amount only when the refuse is piled in a compact heap, not strewn about in haphazard manner, as is too frequently the case along river banks, and thickets. The dust is not effective if heavy rains follow soon after its application.

The napthas are used as sprays in undiluted form. Dow 66 Improved is used at the rate of 3 gallons to 100 gallons of water. Weed Killer 75 is used at the rate of 1 pound of herbicide mixed with 3 gallons of diesel oil and the mixture added to 100 gallons of water. Foliage and refuse heaps should be thoroughly drenched with the spray.

Refuse heaps need to be treated early and retreated as long as sprouts emerge. Several effective means of treating the refuse heaps are now available. More cooperation between growers is needed to effectively cope with the potato refuse problem on a statewide basis.

POTATO SCAB. J. A. Chucka, F. H. Steinmetz. The data obtained from the potato scab experimental plots at Aroostook Farm in 1945 are essentially similar to those obtained in 1944. The amount of common potato scab on the tubers was correlated with the pH and calcium content of the soil. The correlations obtained were .73 and .51 for scab-pH and scab-calcium respectively. Although the potash content of the soil tended to increase slightly with degree of scabbiness the correlation was not significant.

There was no significant correlation between acre yields of potatoes and degree of scabbiness.

The soils on the plots which produced scab-free tubers, or tubers with only a trace, ranged in pH from 4.40 to 5.62. Those that produced tubers with 1 to 5 per cent of their surface covered with scab ranged in pH from 5.36 to 5.79. Those that produced tubers with more than 5 per cent of their surface covered with scab ranged in pH from 5.61 to 6.50.

Although there was considerable overlapping in pH between groups of plots on which tubers with different degree of scabbiness were produced, in general very few tubers with scab were produced on plots with a pH of 5.5 or less. Thus for practical purposes a pH of 5.5 may be considered as the approximate dividing line

between soil conditions which produce clean and those which produce scabby potatoes in Aroostook County.

SOIL FERTILITY

POTATO SOILS NEED LIME. J. A. Chucka, Arthur Hawkins. Experience over a long period of time and numerous experiments have shown that potatoes should be grown in Maine on soils having an acidity represented by a pH of between 5.0 and 5.5. If the soils are less acid than about pH 5.5 the potatoes grown on such soils are likely to be scabby. If the soils are more acid than pH 5.0 the potatoes will not yield as well as they would on less acid soils. Thus the largest yields of potatoes free from scab are produced, under Maine conditions, when the pH is maintained between 5.0 and 5.5.

Leaching, cropping, and the use of fertilizers all tend to make soils more acid. The acidifying effect of these factors may and should be offset by the use of lime. The amount of lime that may or should be applied varies with the degree of acidity of the soil. If the soil has been allowed to become strongly acid as represented by a pH considerably below 5.0 rather large amounts of lime will be necessary to bring the soil back to the desired degree of acidity. On the other hand as the degree of acidity approaches pH 5.5 less lime should be used.

In 1942 a liming experiment was started on a potato farm at Presque Isle, Maine, to secure additional data on the effect of different amounts of two kinds of limestone (calcium limestone and magnesium limestone) and gypsum on soil acidity, clover yields, potato yields, and amount of potato scab. The soil upon which this test was placed was very acid (pH 4.4 to 4.7). Each limestone was applied at the following rates: 500, 1000, 2000, and 4000 pounds per acre. The gypsum was applied at 1000, 2000, 3000, and 4000 pounds per acre. All materials were applied broadcast and harrowed in thoroughly in the spring of 1942 prior to potato planting.

Potato yields taken in the fall of 1942 showed little or no effect from any of the applied materials. Only a few tubers with a trace of scab were found on the plot which had received 4000

FIG. 2. Effect of magnesium limestone on clover. Left 1000 pounds per acre, right 500 pounds per acre.

FIG. 3. Effect of magnesium limestone on clover. Left 2000 pounds per acre, right 1000 pounds per acre.

FIG. 4. Effect of calcium limestone and gypsum on clover. Left 2000 pounds per acre of ground calcium limestone, right 4000 pounds per acre of gypsum.

pounds of calcium limestone. All of the other plots produced scab-free tubers.

In 1943 the plots were seeded to oats and Mammoth clover. No yields were taken of the oats. In 1944 the plots were in clover. The resulting stands of clover are shown in Figures 2, 3, and 4. Where no lime had been applied there was no clover. Where 500 pounds of limestone was applied there was only an occasional clover plant and only a very poor stand of clover where 1000 pounds of limestone was applied (Fig. 2). Where 2000 pounds of limestone was applied (Fig. 3) a very good stand of clover resulted. The use of 4000 pounds of limestone resulted in an excellent stand of clover. At all rates of limestone the clover stands and yields were somewhat better where magnesium limestone was used. (See Table 32.)

Gypsum had no effect on clover stands. There was no clover on any of the plots which had received gypsum even at the 4000-pound rate.

In 1945 these plots were again planted to potatoes. Unfortunately the farmer applied manure to the plots which had little or

no clover, hence the effect of lime applications on potato yields could not be measured. Samples of tubers taken on all plots, however, were examined for scab. Some tubers with scab were found on the plots which had received 4000 and 2000 pounds of limestone. The tubers on all other plots were scab-free. The plot which had received 4000 pounds of calcium limestone had the largest number of tubers with scab. By weight 23 per cent of the tubers produced on this plot had a trace of scab and 17 per cent of the tubers had more than a trace of scab on them. On the plot which had received 4000 pounds of magnesium limestone 5 per cent of the tubers had a trace of scab and 2 per cent had more than a trace. On the plots which had received 2000 pounds of either calcium or magnesium limestone only a few tubers were found with a trace of scab and none with more than a trace. There was no scab on the tubers from the plots which had received gypsum indicating that gypsum has no tendency to favor scab even at the 4000-pound rate of application.

These data substantiate previous findings and indicate that not more than 2000 pounds per acre of limestone should be applied to potato soils at one time even though they are quite acid. They indicate further that as much as 2000 pounds of limestone may be necessary on very strongly acid soils to bring about good stands of clover. However, the recommendation of small applications of limestone (500 to 1500 pounds per acre) applied frequently to potato soils still appears to be sound. Such small frequent applications of limestone will maintain the soil reaction at the desired range in pH (5.0 to 5.5) which will permit the production of good yields of clover and maximum yields of scab-free potatoes.

A recent study of soil conditions on potato farms in Aroostook County indicates that as many as 85 per cent of the farms in central Aroostook have soils more acid than pH 5.0. This indicates that soil acidity is a very important limiting factor in potato yields and that the past rate of lime usage is too low. More lime could be used in either of two ways: higher per acre applications or more frequent use of lower rates. Perhaps both procedures could be used on a few farms where little or no lime has been applied in the past. However, on the majority of farms the latter method, namely, more frequent use of small applications (500 to 1000 pounds per acre) accompanied by frequent soil tests is the safest procedure

by which potato yields could be materially increased without the danger of increasing the amount of potato scab.

Since the soils of Maine are very low in available magnesium, the limestone used should contain a minimum of ten per cent of magnesium oxide. The use of calcium limestone would make it more difficult for plants to get magnesium and might therefore reduce rather than increase yields on those soils which are particularly low in available magnesium.

YIELD RESPONSE OF POTATOES TO INCREASING RATES OF PHOSPHORUS AND POTASH ON SOILS HAVING A WIDE RANGE OF READILY SOLUBLE PHOSPHORUS AND AVAILABLE POTASH. Arthur Hawkins, J. A. Chucka, B. E. Brown.[17] The analytical data obtained from a survey[18] of the soil fertility status of potato farms in Aroostook County, Maine, indicated the need for field experiments to determine the effect of rates of phosphorus applied to potatoes grown on soils having a wide range in readily-soluble phosphorus content. Likewise the need for field experiments to determine the effect of rates of potash applied to potatoes grown on soils having a wide range of exchangeable (available) potash was indicated. Accordingly eleven such rate tests for each of the nutrients were conducted on soils of the predominant soil series in three areas of Aroostook County in 1945.

At six locations on soils relatively low in readily-soluble phosphorus, the rates of phosphorus applied were 40, 80, 120, 160, and 200 pounds P_2O_5 per acre. At locations where the readily-soluble phosphorus content of the respective soils was expected to be relatively high, the O-treament was added and the 200-pound treatment omitted. Treble superphosphate was used as the source of P_2O_5. All plots received the same amount of nitrogen and potash, namely, 100 pounds of N and 200 pounds of K_2O per acre rate.

In the rate of potash tests, potash was applied at the following rates: 100, 150, 200, 250, and 300 pounds K_2O per acre. The treatments were made up so that 100 pounds of nitrogen and 160 pounds of P_2O_5 per acre rate were applied on all plots.

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[17] The studies with potato fertilizers are cooperative with the Division of Soils, Fertilizers, and Irrigation, and Division of Fruit and Vegetable Crops and Diseases. Arthur Hawkins and B. E. Brown, respectively, are the representatives of these Divisions on these studies in Maine.

[18] Data to be presented in a Station Bulletin to be published soon.

In all tests the seed was planted by machine and the fertilizer band-placed by machine.

The growing season in Maine was favorable for potatoes until about the first week in August. However, this was followed by a dry period of nearly three weeks in most of the County, including the areas where the experimental plots were located. At Presque Isle, Maine, which is in the central part of the County, near where five of the plots were located, only .23 inch of rain fell during the period from August 6 to 25 inclusive. This low rainfall occurred at a time when normally under Aroostook conditions tuber enlargement is very rapid. The prolonged period of dry weather was also especially favorable for the rapid development of aphids and flea beetles, resulting in very high populations of these insects which soon seriously damaged or killed the potato plants. Particularly low yields were produced at a test plot where an early variety was planted on relatively gravelly soil.

Rate of Phosphorus Tests in 1945. The yields of potatoes obtained with varying amounts of phosphorus applied are graphically presented in Figure 5. With one exception (at the location indicated at extreme left in Figure 5), statistically significant yield increases above the 40 pounds P_2O_5 per acre rate (2000 pounds 5-2-10) were produced with 80 pounds of P_2O_5 (5-4-10) on soils containing less than an average amount of readily soluble phosphorus.[19] Also, an application of 120 pounds P_2O_5 (5-6-10) usually resulted in an increased yield above the 80-pound rate; these increases, however, were not always significant. At two locations on soils having relatively low amounts of readily soluble phosphorus significant yield increases were obtained with 5-8-10 (160 pounds P_2O_5) as compared with yields produced at the 120 pounds P_2O_5 per acre rate (2000 lbs. 5-6-10).

On the potato soils containing relatively high amounts of soluble phosphorus, as a result of accumulation of phosphorus in the soil particularly on fields which have been planted frequently to potatoes and where large amounts of fertilizer have been applied, yields increased slightly with increasing rates of P_2O_5 applications up to 80 pounds P_2O_5, but in no case was the difference statistically significant.

[19] The average amount of readily soluble phosphorus found in soil samples obtained from potato fields in Aroostook County 1944 survey was 350 pounds per acre of Truog soluble P_2O_5 in 2,000,000 pounds of 2 mm. soil.

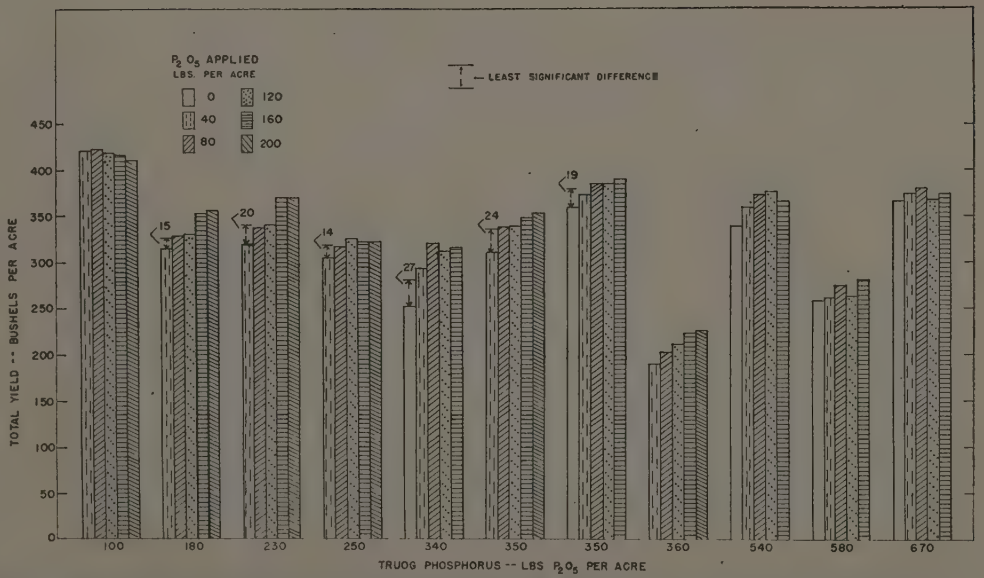

FIG. 5. Yields of potatoes produced with increasing amounts of applied phosphorus (40 lb. increments of P_2O_5) when grown on soils having different amounts of readily soluble phosphorus (Truog phosphorus)—Maine 1945. The indicated amounts of P_2O_5 were applied with 2000 lbs. per acre rate applications of the following mixtures: 5-0-10, 5-2-10, 5-4-10, 5-6-10, 5-8-10, and 5-10-10.

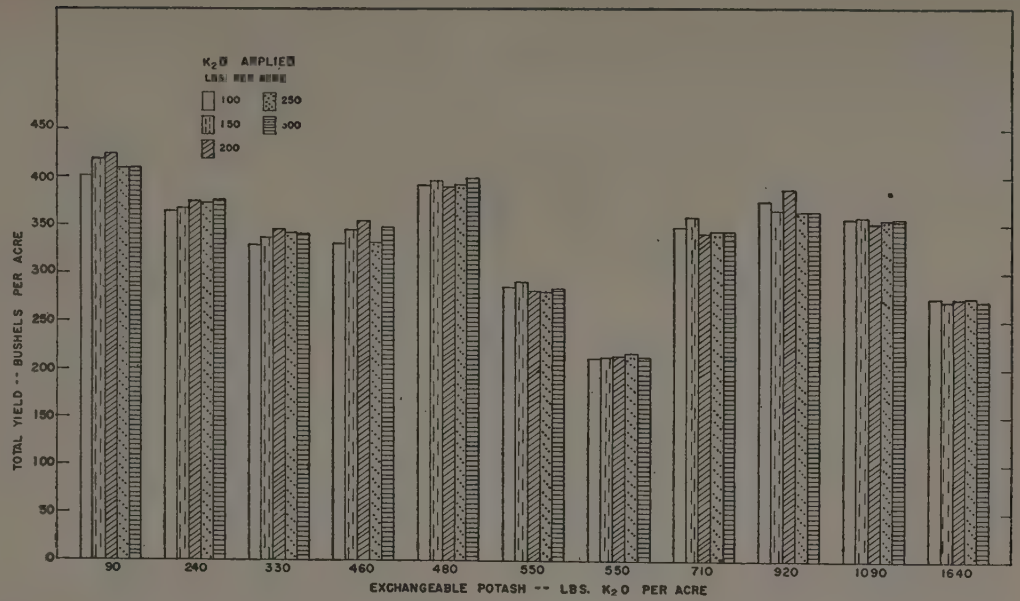

FIG. 6. Yields of potatoes produced with increasing amounts of potash (50 lb. increments of K_2O) when grown on soils having different amounts of exchangeable (available) potash—Maine 1945.
The indicated amounts of potash (K_2O) were applied in 2000 lbs. per acre rate applications of the following fertilizer mixtures: 5-8-5 (100 lbs. K_2O), 5-8-7½ (150 lbs. K_2O), 5-8-10 (200 lbs. K_2O), 5-8-12½ (250 lbs. K_2O), and 5-8-15 (300 lbs. K_2O).

The results obtained under 1945 conditions indicated that an application of 160 pounds of phosphoric acid (P_2O_5) per acre was ample for potatoes even when grown on soils containing less than an average amount of readily soluble phosphorus. On potato soils which had relatively high amounts of accumulated phosphorus, no increase in yield was obtained with the addition of phosphorus greater than 120 pounds P_2O_5 per acre rate.

Rate of Potash Tests in 1945. The relative yields of potatoes from plots which received 100, 150, 200, 250, and 300 pounds of potash (K_2O) per acre on eleven farms, the soils of which varied considerably in accumulated potash,[20] are presented in Figure 6. These comparisons of rate of potash application were made by applying 5-8-5, 5-8-7½, 5-8-10, 5-8-12½, and 5-8-15 each at the rate of 2000 pounds per acre.

On soils having less than a medium amount of exchangeable or readily available potash per acre, small increases in yield were obtained with 150, and 200 pounds of applied potash.

On soils containing more than the average amount of exchangeable potash (500 pounds exchangeable K_2O per acre) little or no increase in yield occurred with applications greater than the 100 pound rate which was the minimum used.

The prolonged unfavorably dry conditions during the growing season may account for these relatively low responses particularly on soils relatively low in exchangeable potash.

GREEN-MANURE CROPS. J. A. Chucka, F. H. Steinmetz. Past experience with green-manure crops for potatoes has indicated that considerably larger amounts of organic matter could be produced with non-legumes than with legumes under Maine conditions. This was particularly true if the green-manure crops were fertilized. However, when the value of the green-manure crop was measured in terms of increased yield of potatoes immediately following the green-manure crop the relatively small yields of legumes usually produced larger increases in potato yields. Sometimes plowing under large amounts of non-legume green-manure crops even depressed potato yields.

The relatively low yields of potatoes following the turning under of large amounts of non-legume organic material may be associated with competition for nitrogen between soil organisms

[20] Expressed in pounds of exchangeable potash per 2,000,000 pounds of 2 mm. soil.

and the potato plants during the time the organic material is being decomposed. Thus an experiment was started at Aroostook Farm in 1943 to study the effect of the addition of nitrogen at the time of plowing under a non-legume green-manure crop. The treatments consist of the use of no nitrogen, 50 pounds, and 100 pounds of nitrogen per acre prior to seeding of the green-manure crop (Japanese millet) and the use of no nitrogen, 50 pounds, and 100 pounds of nitrogen per acre at the time the millet is plowed under. The potato yields obtained following these variously treated millet plots are compared with potato yields following crimson clover and following potates. Some of the plots which were planted to potatoes every year received additional fertilizer in the row while others received extra nitrogen broadcast and harrowed in prior to potato planting. Thus the series of plots provide first, a comparison of potato yields under continuous cropping to potatoes (no organic matter additions) with potato yields from a two-year rotation in which crimson clover or millet is used as a green-manure crop; second, a comparison of extra nitrogen and extra complete fertilizer without organic matter as compared with extra nitrogen plus a green-manure crop; and third, they show the effect of applying several levels of nitrogen at seeding and just prior to plowing, on yields of millet as a green-manure crop and on subsequent potato yields.

The yields of green-manure crops and subsequent potato crops grown on these plots from 1943 to 1945 are shown in Tables 33 and 34. It will be noted that 100 pounds of nitrogen broadcast and harrowed in prior to planting potatoes increased potato yields 16 bushels per acre in 1944 and by 26 bushels in 1945 whereas an extra 250 pounds of 8-12-20 fertilizer applied in the row at planting time resulted in slightly lower yields during both years. The use of crimson clover as a green-manure crop increased potato yields by 37 and 39 bushels per acre as compared with potato yields under continuous potatoes. The use of 250 pounds per acre of fertilizer prior to seeding the crimson clover resulted in only slightly higher yields of crimson clover and subsequent potato yields. The use of 50 pounds of nitrogen prior to seeding of millet resulted in large increases in yield of millet. The use of 100 pounds of nitrogen did not increase the yields of millet beyond those obtained with 50 pounds of nitrogen. The addition of nitrogen at the time of plowing under the millet tended to increase subsequent potato yields. In

general the data obtained from these plots thus far indicate that the use of nitrogen with millet (a non-legume) may be as good or possibly a better practice than the use of crimson clover in supplying organic matter to potato soils. Since the amount of organic matter turned under is greater with millet than with crimson clover it will be interesting to follow the potato yields on these plots for several more years.

SEED STOCK PRACTICES

GREENSPROUTING AND STARTER SOLUTIONS TO HASTEN MATURITY. G. P. Steinbauer. Two possible means of hastening early growth and maturity are the use of starter solutions and greensprouting of the seed potatoes before planting. Greensprouting consists of spreading out the seed potatoes in a single layer, in such a way as to allow a small amount of light to reach the tubers. The barn or warehouse floor or special racks may be used for this purpose. After two or three weeks the tubers will have turned green, and short, tough green sprouts will have developed. When the tubers are cut and planted the stems will emerge much earlier than with untreated tubers. This rapid early development is often reflected in increased yields at harvest time. The method is widely used in European countries, less so in this country. The principal difficulties in applying the method are the requirements for suitable space to carry out the greensprouting and the fact that sprouted tubers cannot be easily handled in machine planters, except in the type used for planting tuber units.

Tubers of the Katahdin variety were spread out on benches in the greenhouse three weeks before planting time. The tubers were covered with three thicknesses of cheesecloth to reduce the light intensity and prevent excessive drying. At the end of the three-week period the tubers and sprouts had developed a dark green color, and leaves were beginning to enlarge. The tubers were cut and planted in six randomized replications. Each replication consisted of a twenty-five foot row with seed pieces spaced twelve inches apart. At the same time a lot of non-greensprouted tubers was planted in similar manner.

A third group of tubers was planted in the same manner as the controls except that ¼ pint of starter solution (10 lbs. of 4-12-4

fertilizer to 50 gals.) was added to the soil around each seed piece at planting time.

Records were made of the number, size, and weight of tubers at time of harvest.

Yields and emergence were very similar for controls and the treatment using starter solution. There was a very pronounced difference in the rate of emergence in favor of the tubers which were greensprouted. This earlier top growth resulted in statistically significant increases in number of tubers and weight of tubers for greensprouted seed as compared to non-greensprouted seed. These results are in agreement with the observations of Hardenburg[21] in New York State that both weight and numbers of tubers usually increase as a result of greensprouting.

The data indicate that greensprouting should be seriously considered as a means of increasing yield in early harvested potatoes.

Chemical Treatment of Seed Potatoes to Control Tuber Size. G. P. Steinbauer, F. H. Steinmetz. Various methods have been used to produce larger numbers of tubers of medium size than would ordinarily be the case. One method in common use is simply to crowd the seed pieces closer together in the row. Spacings as close as 6, 7, or 8 inches are sometimes used by seed growers in contrast to the usual 10 or 12 inch spacing used by growers of table stock. It is naturally wasteful of seed and where the latter is scarce other methods of reducing tuber size are desirable.

Other methods of producing smaller tubers are based on increasing the number of plants or stems per seed piece. One method is to make use of larger seed pieces which normally produce more stems per seed piece than do the smaller pieces. In many instances increased yields result from this practice. However, more barrels of seed are required per acre than when smaller pieces are used. When seed is at a premium it might be desirable to make use of a third method by which more of the buds on the seed piece are stimulated into growth. Certain chemicals such as ethylene chlorohydrin, several thiocyanates and thiourea break this inhibiting effect, allowing more of the buds to develop. Thiourea is particularly effective in causing more than the usual number of sprouts to develop per eye and per seed piece.

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[21] Hardenburg, E. V. Greensprouting Seed Potatoes. Cornell University Agri. Exp. Station, Bul. 632. 1935.

Tubers of the Katahdin variety were planted in six randomized replications of 25 feet of row each with the following treatments: (1) 12-inch spacing (control); (2) 10-inch spacing; (3) 8-inch spacing; (4) whole tubers dipped for 1 hour in a 1 per cent thiourea solution before cutting and planting; (5) cut tubers dipped for 1 hour in a 1 per cent thiourea solution before planting; (6) exposing whole tubers to ethylene chlorohydrin vapors for 24 hours (1 cc. anhydrous chemical per kg. of tubers) before aerating, cutting, and planting; and (7) dipping cut tubers in a .1 per cent solution of transplantone (a patented product containing a combination of growth substances) for 12 hours.

Closer than usual spacing of seed pieces and the thiourea dip treatments proved most effective in increasing numbers and reducing size of tubers. Results of the 1944 and 1945 experiments indicate that the thiourea dip method should be seriously considered for controlling tuber size, particularly if seed is scarce or of unusually high quality and the highest return from a given quantity of seed is important.

POTATO VINE KILLING. G. P. Steinbauer. Studies on effective methods of killing potato vines were continued in 1945. Several new herbicides were tried as possible vine killers. These included certain dinitro cresol or phenol compounds in diesel oil and water emulsions, sodium nitrite, and certain of the petroleum derivative herbicides. The herbicides mentioned above proved faster killing agents than those previously tried with the exception of sulfuric acid. None of these herbicides had detrimental effects on the keeping quality or the sprouting behavior of the tubers when used for seed. Occasional slight discoloration of the vascular bundles of the tubers occurred following the use of some of the vine killers especially the nitrite and dinitrocresol and phenol compounds. Although this does not interfere with the usefulness of the tubers for seed or table stock, still any discoloration may be used as reason for lowering of grade and is, therefore, objectionable.

Two Aroostook County potato growers purchased sulfuric acid sprayers for top killing this last season. Unfortunately the sprayers which were imported from Scotland arrived late in the season so that only limited trials could be carried out. Sulfuric acid has been widely used in Europe for weed control and potato vine killing. Lack of suitable equipment for spraying the acid and

difficulties of handling this very corrosive material limit its use to larger growers or to contract spraying.

POTATO PRODUCTS

POTATO STARCH. Charles A. Brautlecht. Potato starch continues to be in heavy demand and the textile industry has been very short of this starch for sizing fine count warp threads and for fine finishing. There was practically no opportunity to accumulate starch on the part of the starch factory managers and there will undoubtedly be orders that cannot be filled this year.

The starch content of the Maine potatoes used for extraction of starch, 1945 crop to February 26, was low but was better than for the two preceding years. Comparing crops of the last three years, samples from starch factory hoppers, results in per cent were as follows:

	Max.	Min.	Av.
1943 crop (to June 15, 1944)	12.3	9.0	10.6
1944 crop (to April 1, 1945)	13.7[22]	2.5[23]	11.0
1945 crop (to Feb. 26, 1946)	14.1	9.1	12.5[24]

Starch Characteristics. Charles A. Brautlecht. Twenty-nine samples of Maine potato starch 1945 crop potatoes were examined to February 18, 1946, with the following results:

	Av.	Max.	Min.
Moisture (water) %	17.6	22.8	12.3
Total solids (by difference) %	82.4	77.2	87.7
Ash %	0.28	0.01[25]	0.38

[22] Slightly frosted lot of seed Cobblers.

[23] Badly blighted lot.

[24] Twelve and one-half per cent starch in potatoes is equivalent to 21.8 pounds of anhydrous or water-free starch per barrel of 165 pounds potatoes theoretically, or 92 barrels of potatoes yield one ton starch. If the processing efficiency is 75 per cent, this lot would have yielded 9.35 pounds starch for 100 pounds potatoes or 15.4 pounds anhydrous starch per barrel potatoes or 18.2 pounds starch with 15 per cent moisture to 110 barrels potatoes per ton starch equivalent. Obviously, the barrel measure by volume is variable.

[25] Ashed in quartz tray, sample showed some peculiarities, batch process.

Viscosity, 1% soln. in 0.6% NaOH, at 20° Centipoises stormer	7.7	10.3	2.5
Granule size, microns	38	over 100	1
Acid (cc n/10 NaOH per 25 g sample)	5.0	14.6	2.6
Reflectance (whiteness) to MgO photometric	92.5	99.6	84.7
pH of distilled water extract, 10%	6.4	7.3	6.0
Solubles, 10% water extract	0.19	0.52	0.03

Experimental Potatoes. Chas. A. Brautlecht. Fifty-three lots of experimental potatoes,[26] grown on Aroostook Farm, Presque Isle, were examined for starch. Of these, 22 lots were established domestic varieties. Experimental potatoes show higher starch content than do average table or seed potatoes. (See Table 35.) Potatoes received by starch factories are lower, in turn, in starch content than commercial table and seed potatoes.

Quality of Starch Factory Potatoes. Charles A. Brautlecht. Thirty seven samples of 5 kilograms each of 1945 potatoes from starch factory hoppers were examined with the following results:

		out-of-state potatoes	Maine potatoes
Potato starch by calibrated balance %.	Max.	12.7	14.1
	Min.	7.7	9.1
	Av.	10.0	12.5
No. of potatoes to 5 kilograms (11 lbs.)	Max. size	24	29
	Min. size	87	92
	Av. size	40	58

POTATOES FOR DEHYDRATION. Charles A. Brautlecht. Only three samples of Maine potatoes for dehydration were examined in October and November with the following results:

Starch, potato balance, %	Max.	12.3
	Min.	11.0
	Av.	11.8
Total solids	Max.	20.1
	Min.	17.3
	Av.	18.8
Number of potatoes to 5 kilograms.	Min. No. (max. size)	22
	Max. No. (min. size)	41
	Av. No. (av. size)	30
Reducing sugars, %	Max.	3.5
	Min.	1.2
	Av.	2.5

[26] Potatoes provided by R. V. Akeley and F. J. Stevenson of the U. S. Dept. of Agr. from plots at Aroostook Farm.

DEHYDRATED POTATOES. A. Frank Ross, M. T. Hilborn, L. C. Jenness, Emily M. Bartlett. (A report on a joint project of the Quartermaster General's Office, U. S. Army, and the University of Maine.) As a contribution to the war effort, a project on the "Factors Affecting Quality and Storage Life of Dehydrated Potatoes" was undertaken. This project was subsidized by the Quartermaster General's Office and was materially aided by the cooperation of the commercial dehydrators in Maine.

Scorch or Heat Damage. This type of defect appears as a reddish brown discoloration, chiefly in the center of the cube or strip. It was found that it occurred mainly in potatoes high in reducing sugars and could be avoided by use of potatoes low in reducing sugars. The use of sulfite and care in drying will also materially aid in its control.

Graying. Some potatoes produced in Maine were found to turn gray during processing. In practically every case the discoloration was attributed to rapid enzymatic discoloration on the trimming table. It was found that the actual cause of this discoloration was internal injury, largely due to disease. Several defects, such as net necrosis, freezing injury, mahogany browning, injury from chemical top killing, etc., were found to contribute to this type of discoloration but the chief cause was found to be a bacterial disease. The bacterium causes a very faint necrosis in the vascular ring and is often not detected. Repeated tests indicated that in such tubers, the oxidative enzymes in or near the vascular ring were activated causing rapid "pinking" on the trimming table and subsequent blackening. The control measures worked out consist of rigid inspection before buying, rapid and generous trimming and especially of warming the potatoes in hot water or steam before peeling if lye or steam peeling is to be used. The function of the latter treatment is to insure adequate heat penetration to blanch the affected area (vascular ring) without producing excessive peeling losses. It is not effective with abrasive peeling unless the pretreatment cooks the potato to a depth beyond the vascular ring.

Effect of Reducing Sugars on Storage Life. Experiments have shown that the reducing sugar content of the dehydrated product has a very definite effect on shelf-life. Potatoes high in such sugars rapidly become reddish brown to dark brown in color, develop off-flavors, off-odors and change in reconstitutibility. For a given variety, storage life is an inverse exponential function of

the reducing sugar content. It follows, therefore, that potatoes intended for dehydration should be as low in sugar as it is practicable to obtain. Reducing-sugar contents above 2 per cent of the dry weight should be avoided. As some sugar is lost during processing the level in the raw tubers may be slightly higher, namely, not over 3 per cent of the dry weight.

Effect of Moisture on Storage Life. Data have been obtained in agreement with those obtained elsewhere on the effect of the moisture content of dehydrated potatoes on storage life. A reduction in moisture content of about 2.6 per cent approximately doubles the storage life. In-can desiccation by means of calcium oxide is a satisfactory method for attaining low moisture.

Effect of Temperatures on Storage Life. Experiments have shown that the browning reaction in dehydrated potatoes has a very high temperature coefficient. A decrease in temperature of about 6.7° F. approximately doubles the storage life. Consequently the product should be stored at as low a temperature as is practicable.

Effect of Sulfite on Storage Life. It has been known for some time that treatment of the blanched potato with sulfite solutions prior to drying materially increases the stability of the dry product. An attempt has been made to obtain quantitative data on the extent of this effect. Data so far obtained indicate that in general the addition of sulfite at unobjectionable levels will do no more than double the storage life. It is not possible, however, to make a high sugar sample reasonably stable by the addition of sulfite.

Variety Studies. Because of the importance of reducing sugars in dehydration it appeared desirable to determine the reducing sugar characteristics of Maine varieties. Under controlled storage conditions, the Sebago and Cobbler were uniformly lowest in reducing sugars. Katahdin was intermediate and Green Mountain was highest. The Sebago appeared to be the most satisfactory for dehydration.

Attainment of Low Sugars. Analyses of potatoes bought by Maine dehydration plants indicated that during the fall and early winter months sufficient low-sugar potatoes can be obtained to meet dehydration needs. However, during the remainder of the season difficulty would be encountered in finding sufficient low-sugar potatoes. It was strongly recommended that dehydrators test their potatoes for reducing sugars before buying. If it was necessary to use potatoes high in sugar, it was recommended that they be con-

ditioned prior to use. Experiments under controlled conditions indicated that most lots could be brought to a satisfactory reducing sugar level by storage at about 70° F. for 2 to 3 weeks.

An extensive study was made of the reducing sugar content of Maine varieties under controlled storage and data show that it would be possible for a dehydrator to prevent accumulation of extensive amounts of reducing sugars by storing his own potatoes under controlled conditions. Potatoes stored at 45° F. to 50° F. do not accumulate reducing sugars and will remain in good condition for about 3 months. With the exception of the Green Mountain, potatoes stored at 40° to 42° F. are relatively low in reducing sugars and would be satisfactory for dehydration. They keep well all season at such temperatures. Temperatures lower than 40° will cause rapid accumulation of reducing sugars.

New Products. A pilot plant for the preparation of potato granules has been constructed. This product can be reconstituted in 1 minute and possesses several advantages over the older types. The pilot plant will be used in a study of raw material factors in the production of this product and will include a study of the suitability of Maine varieties.

Methodology. Because of the importance of reducing sugars in dehydration, a method was developed for rapid testing of raw potatoes for reducing sugars. The method was devised for use in commercial plants. A method was also developed for determining the specific gravity of raw potatoes and the subsequent conversion of such data to a total solids basis.

ECONOMICS OF THE POTATO INDUSTRY

THE EFFECT OF WARTIME CONDITIONS ON THE PRODUCTION OF POTATOES IN MAINE. William E. Schrumpf. ***Recent Changes in Production Methods on Maine Potato Farms.*** A Station bulletin with this title is ready for printing and will be available shortly. It deals with the effect of the rapid expansion of potato acreage in Maine on crop rotations, soil erosion, potato varieties, farm labor, seed potatoes, fertilizer, cost of production, and new kinds of equipment.

Quality Defects of Maine Potatoes. An analysis has been made on the quality defects of Maine potatoes inspected by the

Federal-State Inspection Service. The analysis is based upon a ten per cent sample of the more than 85,000 cars represented by inspectors' certificates in 1942, 1943, and 1944. The various grade defects are considered in relation to (1) area where potatoes were grown, (2) seasonal trend, (3) potato varieties, (4) grade specifications, and (5) kind of package.

Bruises and cuts constituted the most important grade defect in 1942, sunburn in 1943, and net necrosis in 1944. The potatoes out of grade in 1942 from bruises and cuts amounted to 1.48 per cent of the potatoes inspected, in 1943 from sunburn 1.52 per cent, and in 1944 from net necrosis 2.36 per cent. Second in importance in 1942 was net necrosis, in 1943 bruises and cuts, and in 1944 also bruises and cuts. For the average of the three years bruises and cuts ranked first. The total defects of the carlots inspected in 1942 averaged 4.14 per cent, 5.48 per cent in 1943, and 6.24 per cent in 1944. External defects which exclude net necrosis, hollow heart, and other internal defects averaged 3.08 per cent in 1942, 3.97 per cent in 1943, and 3.83 per cent in 1944. Net necrosis was more prevalent in the cars inspected in northern Aroostook than in either central or southern Aroostook. In northern Aroostook 1.98 per cent of the potatoes inspected had net necrosis compared with 1.64 per cent in central Aroostook and 1.51 per cent in southern Aroostook.

RECENT PUBLICATIONS OF INTEREST TO POTATO GROWERS

Bulletins

No. 434. Treatment of Potato Refuse Piles to Prevent Spread of Late Blight.

No. 439. Size of Whole and Cut Seed and Spacing in Relation to Potato Yields.

Miscellaneous Publications

No. 602. Eradication of Certain Maine Weeds, an Important Step in Control of Potato Diseases Spread by Aphids.

ABSTRACTS OF ARTICLES PUBLISHED IN PERIODICALS

POTATO VARIETIES: THE NEWLY NAMED, THE COMMERCIAL, AND SOME THAT ARE USEFUL IN BREEDING[27]

Each variety is treated with respect to origin, pedigree, derivation of name, use in breeding, and characteristics of tuber, sprout, and plant, in a compilation from forty descriptive publications.

DISCOLORATION CAN BE AVOIDED[28]

Two important types of discoloration which are encountered in dehydrated white potatoes can be controlled. The reddish brown discoloration sometimes referred to as scorch or heat damage was found to be due to some chemical reaction, involving reducing sugars, that takes place at elevated temperatures. The best method of control is to use potatoes that are low in reducing sugar, preferably with less than 3 per cent on a dry weight basis. This involves either selective buying of raw material, conditioning before processing, or both.

A second type was a gray discoloration that developed only in certain regions of the tuber. This type was characterized by rapid pinking of the peeled tuber on the trimming table, followed by a graying of the affected pieces after processing. When potatoes are peeled by any method using heat, the outermost layer, from 1/8 to 1/4 inch deep, will be completely blanched. There is a region, however, between the blanched and the raw areas where cell structure is broken down and oxidative enzymes are still active. In normal tubers this enzymatic activity will have no serious consequences for there is a considerable time lag, sometimes 20 minutes or more, before any discoloration appears. In tubers affected with various diseases, or other types of internal injury, this time lag is lacking, and discoloration may occur on the trimming table or during other steps in the production line before the material reaches the blancher. In Maine the most serious defects in tubers that contributed to this gray discoloration were net necrosis, stem end

[27] This is an abstract of a paper by Donald Folsom having the same title and published in American Potato Journal Vol. 22, No. 8, pages 229-242, 1945.

[28] This is an abstract of a paper by A. F. Ross, M. T. Hilborn, and Lyle C. Jenness having the same title and published in Food Packer 26 (10): 38,40,42,48. September, 1945. It is based on a joint project of the Quartermaster General's Office, U. S. Army, and the University of Maine.

browning, freezing injury, and especially a bacterial vascular necrosis caused by an unknown species of bacterium. A hypothesis involving dihydroxy compounds and tyrosinase is offered to explain how these various disorders of potatoes contribute to the gray discoloration. Recommended control measures include rigid inspection of raw material, generous and rapid trimming, and especially a warming of the potatoes in hot water before they are peeled. The function of the latter treatment is to insure adequate heat penetration to blanch the affected area (vascular ring) without producing excessive peeling losses.

APPENDIX

TABLE 1

Ring Rot Resulting on Contaminated Seed Pieces Treated with Different Materials Possessing Disinfecting Properties[1]

Disinfectant[2]	Chemical	Concentration	Ring rot developing from inoculated seed pieces treated with disinfectant[2]	Ring rot in controls	
				Dipped in water[3]	Not dipped in water
			Per cent	Per cent	Per cent
Hyamine 1622		1–500 1–1000 1–2000	50 58 80	72	66
Isothan Q 15	Lauryl isoquinolinium bromide	1–500 1–1000 1–2000	38 54 64	66	74
DDT	Dichloro-diphenyl-trichloroethane	2 lbs. in 100 gallons	50	57	55
Zerlate	Zinc dimethyl dithiocarbamate	2 lbs. in 100 gallons	84	72	68
Fermate	Ferric dimethyl dithiocarbamate	2 lbs. in 100 gallons 4 lbs. in 100 gallons	68 56	50	50
Dithane	Disodium ethylene bisthiocarbamate	1 qt. in 100 gallons 2 qts. in 100 gallons	34 50	44	54
Arasan	Tetramethyl-thiuram-disulfide	1–30 1–60	68 54	76	62
Thiosan	As Arasan with a wetting agent	1–30 1–60	66 50	76	64
U.S. Rubber #604 (Phygon)	2,3-dichloronaphthoquinone-1,4	.25% .50% 1.00% 2.00%	66 62 66 52	60	58
Mercreoform Violet #1 dust		Seed pieces well covered with dust	44	62	60
Corrosive sublimate controls	Bichloride of mercury	1–1000	1	66	68
Acidified corrosive sublimate controls	Bichloride of mercury and Hydrochloric acid	2–1000 plus 0.2% HCl	0	68	70

[1] Hyamine 1622 supplied by Rohm and Haas Co., Philadelphia, Pa., Isothan manufactured by Onyx Oil and Chemical Co., Jersey City, N. J.; Zerlate, Fermate, Arasan and Thiosan manufactured by Dupont-Semesan & Co., Wilmington, N. J.; Phygon manufactured by Naugatuck Chemical, Naugatuck, Conn.; Mercreoform Violet #1 supplied by H. D. Long & Sons, Park River, N. D.

[2] Freshly cut seed pieces inoculated by being dipped in a heavy suspension of viable bacteria. Percentage infection based on 200 inoculated seed pieces for each disinfectant.

[3] Contaminated seed pieces dipped in water for a five-minute period before being planted in the field.

TABLE 2

Ring Rot Resulting from Treating Contaminated Potato Seed Pieces with Different Copper-Containing Materials

Material[1]	Concentration of disinfectant	Ring rot developing from inoculated treated seed pieces	Ring rot in controls
		Per cent[2]	Per cent[2]
Yellow copper oxide	3 pounds in 100 gallons	30.0	74
Do.	6 pounds in 100 gallons	32.0	
Tri basic copper sulphate (5-minute dip treatment)	5 pounds in 100 gallons	58.0	72
Do.	10 pounds in 100 gallons	56.0	
Tri basic copper sulphate (Treated 12 hours)	5 pounds in 100 gallons	5.0	82
Do.	10 pounds in 100 gallons	8.0	
Basic copper sulphate	5 pounds in 100 gallons	52.0	72
Do.	10 pounds in 100 gallons	40.0	
Copper Oxychloride	5 pounds in 100 gallons	48.0	74
Do.	10 pounds in 100 gallons	44.0	
Copper sulphate	2 pounds in 10 gallons	5.0	72
Do.	4 pounds in 10 gallons	4.0	74

[1] Freshly cut potato seed pieces were contaminated by being dipped in a heavy suspension of the ring-rot organism.
[2] Based on disease reading from 100 inoculated seed pieces planted in the field.

TABLE 3

Yields of Three Ring-Rot Resistant Seedling Varieties Compared with Pawnee and Four Standard Varieties, Aroostook Farm, Presque Isle, Maine—1945

Variety of selection	Characteristics of varieties	Yield per acre[1]—1945	
		Barrels	Bushels
0 55	Late, resistant to ring rot	119±2.77	328± 7.43
40952	Early, resistant to ring rot	114±3.59	314±28.57
47102	Medium late, resistant to ring rot	178±6.53	492±17.88
Pawnee	Medium early, promising for Greeley, Colorado, and other areas	154±2.61	424± 6.37
Green Mountain	Late, standard variety for Maine	163±7.67	451±21.14
Katahdin	Late, standard variety for Maine	116±3.34	320± 3.43
Sebago	Late, standard variety for Maine	137±5.88	377±40.33
Irish Cobbler	Early, standard variety for Maine	137±3.26	378± 9.40

Minimum required for significance is 29.1 barrels at the 1% level and 21.7 barrels at the 5% level.
[1] Yields based on six replicated plots of 25 hills each for each variety in the test.

TABLE 4

Acres, by Varieties, of Potatoes Owned by Federal Farm Security Administration Borrowers and Surveyed for Ring Rot in 1945

Administrative Area	Green Mountain	Katahdin	Chippewa	Sebago	Houma	Irish Cobbler	Sequoia
Fort Kent	132.50	35.75	16.00	2.00	16.00	0.00	0.00
Caribou	189.00	46.00	1.00	23.00	0.00	32.00	0.00
Presque Isle	10.00	101.00	0.00	46.50	23.00	13.00	0.00
Van Buren	180.50	26.00	17.00	2.00	0.00	0.00	2.50
Houlton	45.50	101.00	0.00	0.00	6.00	0.00	0.00
Totals	557.50	309.75	34.00	73.50	45.00	45.00	2.50
		Grand total	1067.25 acres				

TABLE 5

Amount of Ring Rot in Seed Plots and Commercial Plantings of Federal Farm Security Administration Borrowers

Administrative Area	Acreage			
	Seed Plot		Commercial Planting	
	Infected with ring rot	Free of ring rot	Infected with ring rot	Free of ring rot
Fort Kent	0.00	14.75	73.00	131.25
Caribou	0.00	21.50	112.00	189.00
Presque Isle	0.00	18.50	83.00	110.50
Van Buren	5.00	17.25	162.50	65.50
Houlton	0.00	22.75	0.00	140.50
Totals	5.00	94.75	430.50	636.75
Percentage of totals	5.00	95.00	40.30	59.70

TABLE 6

Control Practices in Relation to Ring Rot Infection Among Seed Plot Growers of the Farm Security Administration Program in Aroostook County

Administrative Area	Number of growers	Planted seed plot first	Dug seed plot first	Disinfected or new			
				Planter	Barrels	Bin	Digger
Fort Kent	10	7	6	10	9	8	9
Caribou	10	3	7	9	8	9	7
Presque Isle	9	8	7	7	9	8	6
Van Buren	10	6	7	6	7	6	6
Houlton	9	8	6	9	9	9	9
Totals	48	32	33	41	42	40	37
Percentage of totals	100	66.6	68.7	85.4	87.5	83.3	77.0

TABLE 7

Summary of Ring Rot Survey of Farmers Having Farm Security Administration Seed Plots Located in Five Areas of Aroostook County, Maine

Administrative Area	Seed Plot		Commercial Planting	
	Infected with ring rot	Free of ring rot	Infected with ring rot	Free of ring rot
Fort Kent	0	10	5	5
Caribou	0	10	2	8
Presque Isle	0	9	4	5
Van Buren	3	7	6	4
Houlton	0	9	0	9
Totals	3	45	17	31
Percentage of totals	6.3	93.7	35.4	64.6

TABLE 8

Leafroll Infection in Different Varieties and Selections Resulting from Inoculations with Viruliferous Aphids —1945

Variety	No. plants inoculated[1]	Plants developing current seasonal leafroll symptoms	
		No.	Per cent
1st Test			
Katahdin	23	15	65
Green Mountain	25	21	84
Teton	25	5	20
Sebago	25	18	72
Pawnee	25	5	20
Irish Cobbler	25	8	32
0.55	19	18	95
40952	25	2	8
2nd Test			
Houma	25	5	20
Katahdin	18	2	11
Green Mountain	12	6	50

[1] Inoculations conducted on July 27 in the field using viruliferous *Myzus persicae* from potato plots having leafroll.

TABLE 9

Reactions of Progenies of Different Crosses to Leafroll Infection Resulting from Artificial Inoculations with Viruliferous Aphids

Pedigree number	Parentage	Number seedlings in progeny tested	LR Symptoms		Seedlings that were free from leafroll		Saved for further tests	Net Necrosis in tubers
			Current season	2nd season	No.	Per cent		
B507	President x Katahdin	233	194	38	1	0.4	None	None noted
B511	96-56 x Triumf	110	86	24	10	9.1	7	"
B512	96-28 x Triumf	193	143	38	12	6.2	12	"
B517	792-76 x 1241-91	271	206	48	17	6.3	6	"
B518	792-88 x 1241-91	154	116	34	4	2.6	4	"
B522	792-94 x 1241-91	352	224	89	39	11.1	26	"
B1113	Triumf selfed	471	60	193	218	46.3	39	"

TABLE 10

The Percentage of Net Necrosis Developing in Green Mountain Potatoes Inoculated with Leafroll by Grafting at Intervals Throughout the Season

Date of grafting 1944	Tubers showing net necrosis	Tubers having leafroll 1945	Per cent of tubers having net necrosis
July 5	22	274	8.03
12	34	260	13.08
19	101	264	38.26
26	112	255	43.92
Aug. 2	150	231	64.94
9	244	296	82.43
16	162	229	70.74
23	144	260	55.38
Sept. 2	128	243	52.67

TABLE 11

Number of Samples, by Variety, and Total Acreage Represented in Florida with Percentage Falling into Each of 3 Classes in Florida Test—1945-1946

Variety	No. of samples	Total acreage represented	Percentage of acreage recommended as		Not recommended[3]
			Foundation seed[1]	Table stock seed[2]	
Chippewa	260	2731.0	22	42	36
Cobbler	271	3237.6	54	38	8
Green Mountain	262	3071.8	33	35	32
Houma	9	66.5	5	35	60
Katahdin	296	3522.6	56	41	3
Mohawk	16	18.8	63	16	21
Pontiac	7	8.7	13	5	82
Russet	2	8.0	25	75	0
Sebago	80	696.8	35	49	16
Sequoia	3	9 8	25	0	75
Spaulding Rose	1	0.3	100	0	0
Warba	2	11.0	55	45	0
Totals	1209	13382.9			

[1] Leafroll readings under 2%.
[2] Leafroll readings 2.1% to 10%.
[3] Leafroll readings 10.1% or over.

TABLE 12

The Percentage of the Acreage of Foundation Seed Plots Falling into Each of 3 Classes and a Comparison with the Figures from All Fields Based on 1945-46 Florida Test

Variety	Percentage of acreage recommended as				Not recommended[3]	
	Foundation seed[1]		Table stock seed[2]			
	Seed plot program	All samples	Seed plot program	All samples	Seed plot program	All samples
	%	%	%	%	%	%
Chippewa	67	22	24	42	9	36
Cobbler	97	54	3	38	0	8
Green Mountain	73	33	27	35	0	32
Houma	100	5	0	35	0	60
Katahdin	88	56	12	41	0	3
Mohawk	100	63	0	16	0	21
Pontiac	59	13	41	5	0	82
Russet	—	25	—	75	—	0
Sebago	46	35	54	49	0	16
Sequoia	100	25	0	0	0	75
Spaulding Rose	100	100	0	0	0	0
Warba	—	55	—	45	—	0

[1] 0 to 2% total virus.
[2] 2.1% to 10% total virus.
[3] Over 10.1% total virus.

TABLE 13

The Effect of Date of Planting on Net Necrosis Development
Aroostook Farm—1945

Seed	Planting date	Net necrosis[1] at different digging dates[2]			
		Aug. 20	Sept. 5	Sept. 18	Average
		%	%	%	%
Green Mountain Highmoor strain	May 4	0.0	0.0	0.0	0.0
	May 21	0.0	1.9	1.4	1.1
	June 1	0.9	4.2	1.7	2.3
	June 12	2.1	4.1	5.7	4.0
Green Mountain Keswick strain	May 4	0.0	0.8	0.1	0.3
	May 21	0.7	0.4	0.9	0.7
	June 1	0.3	2.0	1.3	1.5
	June 12	1.8	4.7	5.3	3.9
Irish Cobbler	May 4	0.0	0.0	0.1	0.03
	May 21	0.1	0.3	0.0	0.10
	June 1	0.2	0.0	0.0	0.07
	June 12	0.2	0.3	0.2	0.23

[1] For the Green Mountains, the figures are the average of 4 single row plots, each 25 feet long. Those for the Cobblers are the averages of 8 single row plots, each 25 feet long. All tubers were stored at 50° F. for 100 days or longer before being examined.
[2] Actually the date when tops were killed either by pulling or by frost. Potatoes were dug 7 to 10 days later.

TABLE 14

The Effect of Date of Planting on Net Necrosis Development
Central Maine—1945

Variety	Date planted	Net necrosis[1] at different digging dates[2]			
		Aug. 21	Sept. 7	Oct. 12	Average
		%	%	%	%
Green Mountain	May 3	25.2	21.2	10.6	19.0
	May 21	23.5	25.4	14.5	20.6
	June 2	20.2	25.7	24.1	23.3
	June 14	29.4	19.8	18.0	22.4
Irish Cobbler	May 3	1.7	1.6	1.6	1.6
	May 21	1.6	2.9	3.9	2.8
	June 2	1.4	1.5	1.3	1.4
	June 14	0.0	0.5	3.2	1.2

[1] Average of 8 single rows, each 25 feet long.
[2] Actually the date when tops were killed. Samples dug 7 to 10 days later.

TABLE 15

The Effect of Fertilizer Practice on the Spread of Leafroll
Permanent plots—1944

Green Mountains

Rotation	Treatment (per acre)	Net necrosis[1]			Leafroll[2]			NN/LR x 100		
		Keswick strain	Highmoor strain	Av.	Keswick strain	Highmoor strain	Av.	Keswick strain	Highmoor strain	Av.
		%	%	%	%	%	%	%	%	%
3-year	1500 lb. 4-8-8	21.5	12.9	17.0	39.7	32.5	35.7	54.2	39.7	47.6
	2000 lb. 4-8-8	32.0	39.2	35.3	57.8	73.2	65.4	55.4	53.5	54.0
	2500 lb. 4-8-8	49.3	37.1	42.0	74.5	54.4	62.4	66.2	68.1	67.6
	3000 lb. 4-8-8	35.1	35.0	35.1	67.4	70.8	69.0	52.1	49.4	50.9
	2000 lb. 4-0-8	21.1	16.0	18.6	40.0	38.6	39.3	52.5	41.5	47.3
	2000 lb. 4-4-8	19.7	24.0	22.0	39.7	32.0	34.0	53.7	75.0	64.7
	2000 lb. 4-8-8	32.0	39.2	35.3	57.8	73.2	65.4	55.4	53.6	54.0
	2000 lb. 4-8-8	54.4	82.7	68.6	68.2	57.1	61.0			
	2000 lb. 4-12-8	37.1	47.2	42.1	27.6	48.5	39.1	44.9	44.7	44.5
	2000 lb. 4-8-8 (CP)[3]	12.4	21.7	17.4	67.0	64.1	65.1	59.0	40.2	49.0
	2000 lb. 4-8-8 (CP[3]+MgO)	39.5	25.8	31.9	37.1	50.7	43.8	48.5	38.3	43.1
	2000 lb. 4-8-8 (CP[3]+MgO)	18.0	19.4	18.8	38.8	58.0	49.3	45.4	40.2	41.8
	2000 lb. 4-8-8 (CP[3]+MgO+B)	17.6	23.3	20.6	52.8	35.8	44.2	59.2	55.0	57.2
	2000 lb. 4-8-8 (KCl)[4]	31.5	19.7	25.3	25.6	43.2	35.5	67.2	44.0	48.9
	2000 lb. 4-8-8 (K_2SO_4)[4]	17.2	19.0	18.2	36.9	35.1	36.0	56.1	69.5	62.8
	2000 lb. 4-8-8 (KCl, limed)	20.7	24.4	22.6	28.5	37.4	33.1	61.7	69.0	65.9
	2000 lb. 4-8-8 (K_2SO_4, limed)	17.6	25.8	21.8						
	All plots	**26.4**	**26.8**	—	**46.4**	**51.9**	—	**56.9**	**51.4**	—
Potatoes every year[5]	2000 lb. 4-8-8 (KCl)[4]	14.5	19.2	17.0	10.1	41.8	32.7	80.9	45.9	53.9
	2000 lb. 4-8-8 (K_2SO_4)[4]	23.9	—	—	37.5	58.8	50.8	63.7	—	—
	2500 lb. 4-8-8 (KCl)[4]	55.6	38.1	43.3	94.7	77.1	72.6	58.7	49.4	59.6
	2500 lb. 4-8-8 (K_2SO_4)[4]	33.6	28.4	30.2	51.8	58.2	56.2	64.9	48.8	53.7
	2000 lb. 4-8-10 (KCl)[4]	34.5	31.3	32.4	62.3	74.3	67.8	55.4	42.1	47.8
	2000 lb. 4-8-10 (K_2SO_4)[4]	28.8	35.7	32.7	57.2	60.2	58.6	50.3	59.3	55.8
	All KCl plots	**34.9**			**57.7**	**64.4**				
	All K_2SO_4 plots	**28.8**			**48.8**	**59.1**				

[1] After storage at 50° F. for 100 days or more.
[2] Field readings on 1944 crop replanted in 1945.
[3] Prepared from chemically pure salts containing no nutrient elements other than N, P, and K.
[4] Source of potash.
[5] These plots all received potash in the form of KCl up to 1942. In 1942 and since, one half of each plot received K_2SO_4 as a source of potash.

TABLE 16

Comparison of Insecticides for Aphid Control.—Houlton, Maine

Treatment	Per cent reduction in infestation of each species when compared with check on indicated dates following treatments			
	July 19	July 28 or 30	August 4	Av. all three dates
	All 3[1] species	All 4 species	All 4 species	
DDT aerosol	98	100	99.4	99.1
DDT suspension	91	96.9	98.1	95.3
DDT emulsion	96.4	98	97.7	97.4
DDT dust	100	88	87	91.7
Derris suspension	43	79	80	73
Average	85	92	92	

[1] No foxglove aphids had appeared on July 19. The four species are buckthorn, green peach, potato, and foxglove.

TABLE 17

Leafroll in Next Generation Foliage Following 1945 Applications of Insecticides—Houlton, Maine[1]

Treatment	No. of plants involved	Av. per cent of leafroll for four replicates in next generation foliage[2]
DDT aerosol	411	2.8
DDT suspension	299	2.33
DDT emulsion	271	1.1
DDT dust	387	3.02
Derris suspension	385	1.8
Check	387	0.27

(Potato foliage sprayed with Sinox on August 14 and 16, 1945.)

[1] Samples from same fields for which aphid counts are given in table 16.

[2] Readings from Florida Test.

TABLE 18

Insecticidal Treatment on Reduction in Aphid Population and Yield of Potatoes—Houlton, Maine, 1945

Treatment	Per cent reduction in infestation based on av. of 2 checks	Yield	
		Bbls. per acre	Per cent increase over av. of 2 checks
Benzene hexachloride dust	96	—	—
DDT dust	99.5	232	72
Nicotine dust	83	186	38
DDT emulsion spray (regular boom)	71	185	37
DDT emulsion spray (Slosser boom)	90	199	48
DDT aerosol	90	167	24
DDT atomized spray	50	133	0
Check—Fungicide only	—	143	—
Check—Fungicide only	—	126	—

TABLE 19

Leafroll Spread in Plots Treated with Insecticides Houlton, Maine, 1945[1]

Treatment	Av. per cent of leafroll in next generation foliage on different harvest dates of tubers[2]		
	August 10	August 30	September 27
DDT emulsion (regular boom)	2.0	8.5	16.6
DDT aerosol	3.1	8.0	14.1
Check	—	6.7	9.5

(Data based on an average of 192 tubers for each date.)
[1] Samples from fields for which yield data are given in Table 18.
[2] Readings from Florida Test.

TABLE 20

Yields of Potatoes Following Applications of DDT Suspensions and Emulsions to Unreplicated Plots—Houlton, Maine, 1945

Treatment	Number of applications	Yield in barrels per acre	Per cent increase over check
Farm No. 1			
DDT suspension (2#-100 gals.)	3	183	12
DDT emulsion	6	179	9
DDT emulsion	7	178	8
DDT by-product emulsion (1 qt.-100 gals.)	5	192	17
DDT by-product emulsion (1½ qts.-100 gals.)	5	198	21
DDT by-product emulsion (2 qts.-100 gals.)	5	194	18
Check, fungicide only	0	164	—
Average	—	—	14
Farm No. 2			
DDT suspension (2#-100 gals.)	5	160	16
DDT suspension (5#-100 gals.)	5	144	4
DDT emulsion	5	171	24
Check, fungicide only	0	138	—
Average	—	—	15
Farm No. 3			
DDT suspension (2#-100 gals.)	5	166	18
DDT emulsion	4	161	14
DDT by-product emulsion (1 qt.-100 gals.)	5	170	21
DDT by-product emulsion (1½ qts.-100 gals.)	5	188	33
DDT by-product emulsion (2 qts.-100 gals.)	5	187	33
Check, fungicide only	0	141	—
Average	—	—	24
Farm No. 4			
DDT suspension (2#-100 gals.)	6	181	1
DDT emulsion	5	208	16
Check, fungicide only	0	179	—
Average	—	—	9
Farm No. 5			
DDT suspension (2#-100 gals.)[1]	6	164	24
Check,[1] fungicide only	0	132	—
DDT suspension (2#-100 gals.)	6	180	38
DDT emulsion	6	156	20
Check, fungicide only	0	130	—
Average	—	—	27
Farm No. 6			
Nicotine solution	4	203	50
Check, fungicide only	0	135	—
Av. of all six farms	—	—	20

[1] Sebago variety—All others were Katahdin.

TABLE 21

Leafroll Readings in Crop from Plots Treated with Insecticides. Houlton, Maine, 1945[1]

Treatment	Av. per cent of leafroll in next generation foliage on different harvest dates of tubers[2]	
	September 1	October 3 to 16
Farm No. 1		
DDT emulsion	7.7	19.7
DDT emulsion	—	23.7[3]
Check	3.0	18.3
Farm No. 2		
DDT emulsion	20.4	38.6
Check	22.5	35.6
Farm No. 3		
DDT emulsion	12.	24.6
Check	15.1	12.5

[1] Samples from fields for which yield data are given in table 20.
[2] Leafroll readings from Florida Test.
[3] From part of a plot which had been given two further applications after spraying had been discontinued on the rest of the plot.

TABLE 22

The Effect of Date of Planting on Stem-End Browning and on Yield Aroostook Farm—1945

Seed	Date of planting	Stem-end browning[1] at different digging dates[2]				Yield per acre at[1] different digging dates		
		Aug. 23	Sept. 5	Sept. 18	Av.	Aug. 20	Sept. 5	Sept. 18
		%	%	%	%	Bbl.	Bbl.	Bbl.
Green Mountain Highmoor strain	May 4	5.4	2.9	11.4	6.6	95.0	117.9	126.7
	May 21	5.0	4.0	11.0	6.7	75.4	110.9	116.5
	June 1	11.2	5.8	7.8	8.3	49.6	85.7	95.0
	June 12	10.4	9.1	9.9	9.8	41.4	78.6	92.1
	Average	8.0	5.7	10.0	7.9			
Green Mountain Keswick strain	May 4	13.1	9.3	24.2	15.5	95.3	109.7	115.6
	May 21	18.9	11.4	14.2	14.8	74.8	104.7	117.6
	June 1	25.6	9.1	37.4	24.0	60.3	89.7	109.5
	June 12	33.3	25.6	37.2	32.0	43.4	77.4	80.4
	Average	22.7	13.9	28.3	21.6			
Irish Cobbler	May 4	4.5	7.2	7.4	6.4	110.7	110.0	111.2
	May 21	6.9	9.5	11.6	9.3	98.9	99.9	104.0
	June 1	4.5	4.9	6.8	5.4	86.7	83.6	86.7
	June 12	5.2	7.0	8.7	7.0	70.4	79.5	82.6
	Average	5.3	7.2	8.6	7.0			

[1] The figures for Green Mountain are the average of 4 single row plots, each 25 feet long. Those for Cobblers are the averages of 8 single row plots, each 25 feet long. Stem-end browning readings were made after the tubers were stored at 50° F. for 100 days or more.
[2] Actually the date when tops were killed, either by pulling or by frost. Potatoes were dug 7 to 10 days later.

TABLE 23

The Effect of Date of Planting on Stem-End Browning and on Yield Central Maine—1945

Variety	Planting date	Stem-end browning[1] at different digging dates[2]				Yield[1] per acre at different digging dates[2]		
		Aug. 21	Sept. 7	Oct. 12	Av.	Aug. 21	Sept. 7	Oct. 12
		%	%	%	%	Bbl.	Bbl.	Bbl.
Green Mountains Highmoor strain	May 3	1.2	1.3	2.0	1.5	55.6	73.3	75.6
	May 21	2.1	1.2	1.2	1.3	47.6	59.8	62.3
	June 2	2.2	3.0	1.1	2.1	29.0	38.8	49.3
	June 14	4.1	4.3	1.0	3.1	13.4	23.9	24.9
	Average	2.4	2.3	1.3	2.0			
Irish Cobbler	May 3	0.3	1.6	0.3	0.7	62.9	73.4	76.2
	May 21	1.6	2.9	0.2	1.6	61.7	56.8	65.2
	June 2	0.9	1.5	0.0	0.8	34.0	35.4	40.5
	June 14	0.8	0.5	0.0	0.4	16.0	21.2	22.5
	Average	0.9	1.6	0.1	0.9			

[1] The figures in these columns are the averages of 8 single row plots, each 25 feet long.
[2] Actually the date when tops were killed, either by pulling or by frost. Potatoes were dug 7 to 10 days later.

TABLE 24

The Effect of Continued Propagation of Green Mountain in Maine on Susceptibility to Stem-End Browning Aroostook Farm

Field	Seed	Years grown in Maine	Stem-end browning[1]
1	Minnesota Lot[2]	First year	7.2
	Minnesota Lot	Second year	10.7
	Minnesota Lot	Fourth year	10.6
	Highmoor strain	Many	9.1
	Keswick strain	Many	31.6
2	Minnesota Lot	Fourth year	9.4
	Highmoor strain	Many	9.9
	Keswick	Many	36.6

[1] After storage at 50° F. for 100 days or more. Each figure is the average of 5 single row plots, each 29 feet long. Latin Square design.
[2] Seed for 1945 planting obtained direct from the same grower in Minnesota that supplied the previously obtained seed.

TABLE 25

The Effect on Yield of Spraying Katahdin Potatoes with Different Fungicides and with Combinations of These Fungicides with DDT

Fungicide	Formula	Yield per acre[1]		Increase from applying DDT	
		Without DDT	With DDT[2]		
		Barrels	Barrels	Barrels	Per cent
Bordeaux control	8-4-100	129	150	21	16
Basic copper sulphate	4-100	130	161	31	24
Basic copper arsenate	4-100	132	164	32	24
Fermate	2-100	115	135	20	17
Karbam Z	2-100	132	155	23	17
Karbam Z and soap	2-100	126	149	23	18
Dithane	2 qts., 1 lb. $ZnSO_4$ and ½ lb. lime	128	161	33	26
DDT, no fungicide	2-100	—	124	—	—
Unsprayed control	—	110	—	—	—

[1] Average of nine replicated two-row plots each 25 feet in length for each treatment.
[2] Two pounds of 50 per cent DDT (1 pound of actual DDT) added to 100 gallons of spray material.

TABLE 26

Comparison on the Control of Early Blight, Late Blight, Flea Beetles and Aphids by Spraying Katahdins with Different Fungicides With and Without DDT[1]

Fungicide	Formula	Protective coefficient[2]							
		Early blight		Late blight		Flea beetles		Aphids	
		Without DDT	With DDT	Without DDT	With DDT	Without DDT	With DDT	Without DDT	With DDT
Bordeaux control	8-4-100	100	120	100	108	100	142	100	157
Basic copper sulphate	4-100	89	96	100	107	96	161	131	171
Basic copper arsenate	4-100	89	83	98	101	103	149	77	174
Fermate	2-100	92	107	75	70	80	124	101	157
Karbam Z	2-100	115	111	87	84	90	127	114	164
Karbam Z and soap	2-100	119	122	86	88	92	134	111	173
Dithane	2 qts., 1 lb. $ZnSO_4$ and ½ lb. lime	97	104	99	105	65	132	101	162
DDT, no fungicide	2-100	—	22	—	4	—	92	—	146
Unsprayed control	—	24	—	10	—	20	—	77	—

[1] Using data secured from some plots as recorded for in Table 25.
[2] Equal to the infective index for Bordeaux (which is 100) divided by the infective index of the treatment compared. (Adapted from Horsfall, James G. and John W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32: 226-232. 1942.)

TABLE 27

Effect on Yield and the Control of Diseases and Insects from Dusting Mohawk Potatoes with Basic Copper Sulphate Dust and This Material in Combination with DDT. Basic Copper Sulphate Spray, Bordeaux Mixture, Cuprocide Talc Dust, and Copper Lime Dust Included for Comparison

Fungicide	Per cent metallic copper content of formula	DDT content	Yield per acre[1]	Increase from DDT	Protective coefficient for control[2]			
					Late blight	Early blight	Flea beetle injury	Aphids
		Per cent	Barrels	Barrels				
Basic copper sulphate talc dust	4%	None	144	—	85	69	84	93
Do.	4%	1	171	27	93	93	110	129
Do.	9%	None	152	—	80	76	90	98
Do.	9%	1	169	17	99	93	108	125
Do.	9%	3	175	23	107	103	119	133
Copper lime dust	9%	None	144	—	86	63	67	98
Cuprocide talc dust	4%	None	150	—	88	88	79	89
Basic copper sulphate spray	4-100	None	157	—	94	100	78	67
Bordeaux spray	8-4-100	None	134	—	100	100	100	100
Unsprayed control	None	None	152	—	34	58	60	81

[1] Each yield is the average of five replicated two-row plots each 25 feet long.

[2] Equal to infective index of Bordeaux treatment (which is 100) divided by infective index of other treatments being compared. (Adapted from Horsfall, James and Jonn W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32: 226-232. 1942.)

Significance at 1 per cent level is 26.9 barrels. Significance at 5% level is 20.1 barrels.

TABLE 28

Yield Comparison and Control of Late Blight, Flea Beetle Injury and Aphids with Different Dust Fungicides and Combinations with DDT. Bordeaux and Basic Copper Sulphate Sprays and Unsprayed Controls Included for Comparison—Katahdin Variety

Fungicide	Formula	Yield per acre[1]	Protective Coefficient[2]		
			Late blight	Flea beetles	Aphids
		Barrels	Per cent	Per cent	Per cent
Basic Copper Sulphate Talc Dust	7% Copper	101±14.89	72	86	90
Basic Copper Sulphate Talc Dust and DDT	9% Copper and 3% DDT	131±12.91	101	120	135
Copper Lime Dust	9% Copper	118± 8.58	94	86	103
Karbam Z Dust and DDT	3% Karbam and 3% DDT	116±13.57	89	129	128
Basic Copper Sulphate Spray	4-100	117±17.06	102	98	115
Bordeaux Mixture Spray	8-6-100	114±12.44	100	100	100
Untreated Control	None	48±12.46	13	66	113

[1] Based on eight replicated two-row plots each 75 feet in length.
[2] Equal to infective index of Bordeaux mixture control plots (which is 100) divided by infective index of treatments compared. (Adapted from Horsfall, James G. and John W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32: 226-232. 1942.)
Significance at 1 per cent level is 18.25 barrels per acre and at 5 per cent level 13.6 barrels per acre.

TABLE 29

Summary Yields—Barrels and Bushels Per Acre for Katahdins Receiving Applications of Different Spray and Dust Fungicides[1]

Fungicide	Formula	Yield rate per acre[2]		Condition of foliage in field	Protective coefficient[3]
		Barrels	Bushels		
					Per cent
Bordeaux mixture	8-6-100	123±2.72	330±7.48	Green. Slight trace late blight	100
Basic copper sulphate spray	4-100	126±1.75	346±4.80	Fairly green. Beginning to ripen. Trace late blight and early blight	96
Monohydrated copper lime dust	9% metallic copper	116±2.48	318±6.80	Partly green. Beginning to ripen. Late blight and early blight quite severe	84
Yellow cuprocide talc dust	4.1% metallic copper	116±2.27	319±6.21	Mostly dead. Late blight, also early blight quite severe	57

[1] Applications made with tractor power equipment.
[2] Based on 18 replicated two-row plots each 100 feet in length.
[3] For early and late blight calculated by formula of Horsfall and Heuberger expressed as percentage of the disease index of Bordeaux mixture which is 100 per cent.

TABLE 30

Summary Yields—Barrels and Bushels Per Acre of Katahdins Sprayed with Different Fungicides—1945

Fungicide	Formula	Yield per acre[1]		Protective coefficient[2]		
		Barrels	Bushels	Late blight	Early blight	Flea beetles
Bordeaux	8-6-100	130	360	100	100	100
Cuprocide	2-100	137	377	89	72	77
Compound A	4-100	132	363	90	81	74
Tri basic copper sulphate	4-100	132	363	99	88	68
Basic copper arsenate	4-100	131	360	89	80	103
Unsprayed except for control of Colorado potato beetles	—	112	308	14	22	18

[1] Average of six replicated two-row plots each 25 feet long.
[2] Equal to infective index of Bordeaux plots (which is 100) divided by infective index of treatment compared. (Adapted from Horsfall, James G. and John Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32:226-232. 1942.)

Significance at 1 per cent level is 19.78 barrels.
Significance at 5 per cent level is 26.75 barrels.

TABLE 31

Effect of Different Organic Fungicides on Yield and the Control of Late Blight, Early Blight, Flea Beetles and Aphids with the Katahdin Variety. Bordeaux Mixture and Basic Copper Sulphate Included for Comparison

Fungicide	Formula or concentration per 100 gallons	Yield per acre[1]		Protective coefficient[2]			
				Late blight	Early blight	Flea beetle	Aphid
		Barrels	Bushels	Per cent	Per cent	Per cent	Per cent
Bordeaux	8-4-100	131	360	100	100	100	100
Basi-cop (basic copper sulphate)[3]	4-100	131	360	100	88	96	131
Karbam Z (zinc dimethyl-dithiocarbamate)[3]	2-100	132	363	87	115	90	113
Karbam Z (zinc dimethyl-dithiocarbamate plus soap)[3]	2-100	127	349	87	119	92	111
Zerlate (zinc dimethyl-dithiocarbamate)[4]	2-100	123	337	97	82	75	96
Fermate (ferric dimethyl-dithiocarbamate)[4]	2-100	116	318	75	92	80	101
Dithane (disodium ethylene bisdithiocarbamate) plus zinc sulphate and lime[5]	2 quarts plus 1 lb. zinc sulphate and ½ lb. lime in 100 gals.	129	355	99	97	64	100
Isothan Q15 (lauryl isoquinolinium bromide)[6]	1 pt. 100 gallons	114	314	43	35	60	100
Phygon (2-3 dichloro-naphthoquinone-1-4)[7]	1-100	109	300	102	78	60	112
Puratized (Phenyl mercuri triethanol ammonium lactate)[8]	0.8-100	108	299	90	97	60	107
Check (unsprayed except for control of Colorado potato beetles)	—	110	302	10	24	20	77

[1] Based on nine replicated 2-row plots each 25 feet in length for each tr eatment.
[2] Equal to infective index of Bordeaux plots (which is 100) divided by infective index of treatment compared. (Adapted from Horsfall, James G. and John W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32:226-232. 1942.)
[3] Supplied by Sherwin-Williams Company, Philadelphia, Pennsylvania.
[4] Supplied by E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware.
[5] Supplied by Rohm and Haas, Philadelphia, Pennsylvania.
[6] Supplied by Onyx Oil and Chemical Co., Jersey City, New Jersey.
[7] Supplied by Naugatuck Chemical Division of U. S. Rubber Company, Naugatuck, Connecticut.
[8] Puratized Supplied by Puratized, Inc., New York, New York.

Significance at 1 per cent level is 11.95 barrels or 30.39 bushels.
Significance at 5 per cent level is 9.04 barrels or 24.86 bushels.

TABLE 32

Clover Yields as Affected by Gypsum and by Kind and Amount of Limestone Maine—1944

Treatment—lbs. per acre	Acre yields of clover pounds dry matter
No lime	937
500 pounds calcium limestone	868
1000 pounds calcium limestone	951
2000 pounds calcium limestone	4428
4000 pounds calcium limestone	5291
500 pounds magnesium limestone	1212
1000 pounds magnesium limestone	2521
2000 pounds magnesium limestone	5015
4000 pounds magnesium limestone	4299
1000 pounds gypsum	606
2000 pounds gypsum	772
3000 pounds gypsum	661
4000 pounds gypsum	716

Gypsum and limestone applications were made in the spring of 1942. The land was planted to potatoes in 1942, to oats and clover in 1943, and was in clover in 1944.
The yields for each treatment are based on an average of four 1/5000 acre squares.

TABLE 33

Utilization of Nitrogen in the Production and Use of Green Manure Crops for Potatoes—Maine 1943-44

Treatment for green-manure		Green manure yields 1943	Fertilizer applied for potatoes, acre rate	Potato yields 1944	+ or — Check
At Seeding	At Plowing	lbs. dry matter per A.		Bu. per acre	bushels
Potatoes every year					
None	None		1250# 8-12-20	378	Check
None	100# N[1]		1250# 8-12-20	394	+ 16
None	None		1500# 8-12-20	377	— 1
Crimson clover plots (2-year rotation)					
None	None	2746	1250# 8-12-20	415	+ 37
250# 8-12-20	None	3185	1250# 8-12-20	427	+ 49
Millet plots (2-year rotation)					
None	None	2498	1250# 8-12-20	380	+ 2
50# N	None	3391	1250# 8-12-20	411	+ 33
50# N	50# N	8030	1250# 8-12-20	430	+ 52
50# N	100# N	9142	1250# 8-12-20	412	+ 34
100# N	50# N	7811	1250# 8-12-20	409	+ 31
100# N	100# N	7838	1250# 8-12-20	447	+ 69

Green-manure crops grown in 1943 and followed by potatoes in 1944.
Size of plots 16′ x 132′.
All yields are averages of two plots.
Nitrogen (N) was applied as Uramon.
[1] This nitrogen was applied broadcast and harrowed in prior to potato planting.

TABLE 34

Utilization of Nitrogen in the Production and Use of Green Manure Crops for Potatoes—Maine 1944-45

Treatment for green-manure		Green manure yields 1944	Fertilizer applied for potatoes, acre rate	Potato yields 1945	+ or — Check
At Planting	At Plowing	lbs. dry matter per A.		Bu. per acre	bushels
			Potatoes every year		
None	None		1250# 8-12-20	373	Check
None	100# N[1]		1250# 8-12-20	399	+ 26
None	None		1500# 8-12-20	367	— 6
			Crimson clover plots (2-year rotation)		
None	None	4088	1250# 8-12-20	412	+ 39
250# 8-12-20	None	4738	1250# 8-12-20	408	+ 35
			Millet plots (2-year rotation)		
None	None	4351	1250# 8-12-20	385	+ 12
50# N	None	6435	1250# 8-12-20	395	+ 22
50# N	50# N	7176	1250# 8-12-20	417	+ 44
50# N	100# N	7108	1250# 8-12-20	429	+ 56
100# N	50# N	5977	1250# 8-12-20	406	+ 33
100# N	100# N	6424	1250# 8-12-20	419	+ 46

Size of plots 16' x 132'.
All yields are averages of two plots.
Nitrogen (N) was supplied as Uramon.
Green-manure crops were grown in 1944 and followed by potatoes in 1945.
[1] This nitrogen was applied broadcast and harrowed in prior to potato planting.

TABLE 35

Starch Content of Experimental Potatoes—1945

No.	Sample	Per cent starch[1]	No. to 5 kg.	No.	Sample	Per cent starch	No. to 5 kg.
1819	792-96	13.0	32	1958	LaSalle	15.3	29
1820	792-135	15.8	52	1959	Irish Cobbler	16.0	26
1821	792-76	13.9	37	1960	46962	12.5	26
1822	Mohawk	16.4	24	1961	96-44	15.1	25
1823	Earlaine No. 2	12.4	29	1962	Triumph	13.1	29 red skin
1824	B 70-5	14.7	20	1963	96-56	15.6	22
1825	Sebago	15.3	25	1964	Mesaba	15.0	27
1826	Katahdin	13.9	22	1966	Chippewa	12.6	29
1827	Green Mountain	17.0	29	1967	Alamaine	12.6	27
1828	Pawnee	14.9	28	1968	47499	13.8	27
1829	47258	13.3	25	1969	Earlaine	13.0	34
1830	Houma	15.0	31	1970	DeSota	13.1	43 red skin
1831	Pontiac	15.4	25 red skin	2222	Eigenheimer	19.2	80
1832	Norkota	14.2	33	2223	Erdgold	18.8	76
1833	47102	14.5	23	2224	Iduna	20.1	79 red skin
1834	627-126	14.6	31	2225	Matador	20.2	40
1835	792-88	15.1	32	2226	Record	20.6	60
1836	792-94	16.7	29	2227	Robusta	21.3	74
1837	Chippewa	13.2	24	2228	Thorbecke	18.6	84
1838	Sequoia	15.2	19	2230	Ultimus	18.5	109 red skin
1839	White Rose	14.2	27	2232	Fruhegold	14.0	72
1840	Russet Burbank	13.6	30	2233	Ostbote	19.8	74
1841	Kasota	13.7	32 red skin	2234	Voran	18.6	89
1842	627-103	14.7	32	2235	Mittlefruhe	17.2	74
1843	47528	12.2	26	2236	Prisca	17.3	66
1844	792-133	13.8	35	2237	Starkeragis	22.3	64
				2239	Ackersegen	17.3	58

[1] The potatoes were kept in storage at 42 degrees F., plus or minus 4 degrees until tested.